DOCUMENT RESUME

ED 127 247 SO 009 357

AUTHOR Ott, Mary Diederich, Ed.; Reese, Nancy A., Ed.
TITLE Women in Engineering--Beyond Recruitment. Proceedings of the Conference (Cornell University, Ithaca, New York, June 22-25, 1975).
SPONS AGENCY Cornell Univ., Ithaca, N.Y. Coll. of Engineering.; Du Pont Corp., Wilmington, Del.; General Motors Corp., Detroit, Mich.
PUB DATE [75]
NOTE 216p.; Not available in hard copy due to too small type size; For a related document, see SO 009 358

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Career Choice; *Career Education; Career Opportunities; Career Planning; Conference Reports; Educational Problems; *Engineering; Engineering Education; *Females; Higher Education; Literature Reviews; Problems; Science Education; *Student Problems

ABSTRACT

This report contains invited papers and comments from a conference on the status and problems of women in engineering. First, a discussion of research reveals that most women choose engineering as a field for college study late in their secondary education, depend heavily on external sources of support, and have attitudes and experiences different from male freshman engineers. Session two examines barriers to achievement--underrepresentation in class, lack of role models, male-oriented recruitment policies, and low salaries. Persistance and assertiveness are seen to be necessary to deal with these problems. Session three explores the isolation, frustration, and sacrifices experienced by women wanting both a career and family life. Laboratory and research skills are discussed in session four, along with a description of a basic lab-skills course at Cornell and a support program at Purdue to reduce attrition among women science students. Career choice implications and information systems available to women who are making career decisions are reviewed in session five. The two final sessions comment on experiences of women graduate engineering students and the need for society to accept women among its new engineers. (AV)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

ED127247

WOMEN IN ENGINEERING ... Beyond Recruitment

SP009357

PROCEEDINGS OF THE CONFERENCE

JUNE 22 to 25, 1975
CORNELL UNIVERSITY
ITHACA, NEW YORK

Edited by MARY DIEDERICH OTT
NANCY A. REESE

WOMEN IN ENGINEERING--BEYOND RECRUITMENT

Edited by

Mary Diederich Ott
and
Nancy A. Reese

PROCEEDINGS

of the Conference held

June 22 to 25, 1975
Cornell University
Ithaca, New York

"Women in Engineering--Beyond Recruitment"

June 22 to 25, 1975

Cornell University
Ithaca, New York

SUPPORTED BY:

E.I. DuPont de Nemours & Co.
General Motors Corporation
Cornell University College of Engineering

CONFERENCE DIRECTORS:

Robert E. Gardner
David C. Johnson
Mary Diederich Ott

CONFERENCE ASSISTANT:

Nancy A. Reese

Editors' Note:

The conference "Women in Engineering--Beyond Recruitment" included invited papers, reponses by panelists, workshops, and question/answer sessions. All of the invited papers are included in this volume, as well as most of the other material. However, in the interests of space, some of the discussions have been abbreviated or omitted.

CONTENTS

WELCOME: Malcolm S. Burton, Associate Dean.....1
College of Engineering, Cornell University

SESSION I: RESEARCH ON FRESHMAN ENGINEERS
Chairpersons: R. Gardner, D. Johnson, M. Ott
PAPERS: "An Historical Sketch of Research on Female Engineers in the College of Engineering at Cornell" Robert E. Gardner.....1
"The Pre-Freshman Female Engineer: The Chronology and Support of Educational Choices" David C. Johnson.....5
"Attitudes and Experiences of Freshman Engineers at Cornell" Mary Diederich Ott.....13
"The New Pioneers...Women Engineering Students" Engin Inel Holmstrom.....19
QUESTIONS AND ANSWERS.....28

SESSION II: THE ACADEMIC WOMAN: BARRIERS TO ACHIEVEMENT
Chairperson: M. Dresselhaus
PAPERS: "A Constructive Approach to the Education of Women Engineers" Mildred S. Dresselhaus.....37
"The Problems Facing Women Scientists and Engineers in Academia--A Review" Margaret E. Law.....40
"Assertiveness: A Key to Achievement" Sandra O. Davis.....49
"The Female Engineering Student: What Makes Her Tick" Paddy W. Gough.....52
QUESTIONS AND ANSWERS.....62
SUMMARY OF WORKING SESSIONS.....66

SESSION III: THE SOCIAL SCENE--ISOLATION AND FRUSTRATION
Chairperson: H. O'Bannon
PAPER: "The Social Scene: Isolation and Frustration" Helen B. O'Bannon.....69
RESPONDENTS: Lilli S. Hornig.....77
Sheila Widnall.....78
Martha Kopp.....80
Athena Theodore.....80
QUESTIONS AND ANSWERS.....82

SESSION IV: WOMEN IN THE LAB--I'LL TAKE THE DATA
Chairperson: M. Sloan
PAPERS: "Women in the Laboratory" Martha S. Sloan.....88
"Basic Laboratory Skills Course at Cornell" Thomas Hall and Carol Hall.....89
"New Avenues" Dennis Shay.....94
"Involvement of Students in Research Projects" Lynne H. Brown.....98
QUESTIONS AND ANSWERS.....106
SUMMARY OF WORKING SESSIONS.....108

SESSION V: DECISIONS, DECISONS--WHAT SHOULD I DO?
Chairperson: J. Parrish
PAPERS: "Women Engineering Students and the Career Decision Making Process--How Can It Be Improved?" John B. Parrish....111
"Decision Making by Female Undergraduates in Engineering: Patterns, Problems, and Programs" Robert E. Gardner....123
"Career Interruptions and Perceived Discrimination Among Women Students in Engineering and Science" Esther Lee Burks....134
QUESTIONS AND ANSWERS....141

SESSION VI: WOMEN GRADUATE STUDENTS IN ENGINEERING
PANELISTS: Helen B. O'Bannon....143
Irene C. Peden....144
Aghavni A. Bedrossian....148
Paula Stone....150
QUESTIONS AND ANSWERS....152

SESSIONS VII: WOMEN--THE NEW ENGINEERS
Chairperson: I. Peden
PAPER: "Women: The New Engineers" Robert E. Gardner....158
RESPONDENTS: Irene C. Peden (Questions)....171
J. Melissa Brown....173
Marilyn L. Sessions....175
Sherry Koenig....176
Robert A. Charpie....177
Shirley A. Holmgreen....182
QUESTIONS AND ANSWERS....186

LIST OF CONFERENCE PARTICIPANTS....203

Session I: Research on Freshman Engineers

Malcolm S. Burton, Associate Dean, College of Engineering, Cornell University: I bid you welcome to Cornell. Being an engineer and, I guess, something of a pragmatist, when I say "welcome to Cornell" I have to immediately think, "Well, what does that mean?" And, of course, welcome means we're glad you were able to come. We think that this should be a very interesting program. We have a number of, I hesitate to say, problems in dealing with women in engineering. They are not really problems, but the situation is somewhat different. We'd like to share them with you and we hope this will be profitable for you.

We say "Welcome to Cornell." What is Cornell? I'm sure you would be interested in a brief run-down on that. Seventeen thousand students are enrolled. We have a somewhat unique administrative setup in that a portion of the University, something close to half, is state-supported, and a portion of the University is privately endowed. So we have a state university and a privately endowed university all on the same campus. The Engineering College is part of the endowed university; something over 2,200 undergraduate students at the moment, something over 600 graduate students. In the fall of 1974 in the College of Engineering, we had 635 freshmen, 562 of these were men, 73 of these were women. We operate here with a Division of Basic Studies which encompasses the first two years of the program. Students take common courses, and after two years in Basic Studies, students then enter one of the many upperclass fields. There are eleven of those possibilities.

Cornell has always been a coeducational university, but, up to a few years ago, very few of the women entered the field of engineering. Just to give you a very brief picture of that, I've reviewed my data and found that in 1970 we had 9 freshmen; in 1971, 22; in 1972, 30; in 1973, 46; in 1974, 73 women. And I understand from Dave Johnson, Director of Admissions, that over 80 are expected this coming fall.

So I hope that I learn much, that we learn much, from this conference. I hope that it is profitable for you. And, a warm welcome to Cornell.

"A Historical Sketch of Research on Female Engineers in the College of Engineering at Cornell"
R.E. Gardner

The flow of females entering engineering has reached epidemic proportions; the rate of increase over the past 3-4 years is exponential, and as Engin Holmstrom will point out, this year it appears the number may double. This statistic, encouraging as it is, is not the most important from an educational point of view because it does not tell us anything about the educational experience of these students. A more meaningful statistic is the increase in the number of institutions having a critical number (n=30) of females in the matriculating class: in 1972 you could count the number of these institutions on one hand, but last year, 1974, there were 42 such institutions, and this fall the number may approach 75. Of these 42 institutions last year, 35 had

no significant historical experience in educating women and if there are 75 this year, more than 65 will be in the same situation. As a result we have passed from a period in which it was logistically easy to discuss the participation of females to a situation where this is much more difficult because the population has dispersed itself. While there are many serious repercussions of this dispersal that need to be discussed, one critical need is to disseminate whatever information is available--which at the moment appears to be very little. The other critical need is to develop information, and we must rely on the schools that have a critical mass of females to generate research programs to provide data.

Consequently, I'd like to open the conference by asking you to focus on an important question that is "tricky" in the sense that if I place the question to you personally at this moment, you would probably give me a quick reply in an "obvious answer" tone of voice--and then suddenly realize you might want to stop and think a little. If I asked the person next to you the same question they would probably respond in exactly the same way; but their reply would almost certainly be different in substance, suggesting that the answer really is not obvious. Having forwarned you, here's the question: Why invest resources, your resources, on research concerning the attitudes, characteristics and expectations of females entering engineering? Or, more to the point, why should the Dean of your institution invest resources on such research?

For Cornell the answer lies in personalities and historical accidents. In 1971, the year I joined the staff as Assistant to the Dean, I was given responsibility for administering the faculty advising program; that summer, before I began the process of matching students with faculty advisers, David Johnson, Director of Admissions informed me that for the first time we had a sizable number of women in the class and a sizable number of bioengineers. Since at that time we matched primarily on the basis of intellectual interest, the women were scattered among faculty advisers on this basis, whereas the bioengineers were concentrated with two advisers--primarily with me. Had I known that women concentrate themselves in certain fields and are disproportionately interested in interdisciplinary study, I would have suspected what actually materialized: seven of my thirty advisees were female. During the course of the year the novelty of advising a comparatively large number of females wore off and my enthusiasm turned to chagrin, as six of the seven did not continue into the sophomore year. Though my confidence in my advising prowess was bruised that year, the chance concentration of females paid one particularly large dividend: it made me wonder if women in engineering were subject to unique pressures that caused a higher attrition rate. Moreover, if the participation of females looked like a long term development, and Dave Johnson quickly assured me that it did (the number of females entering the next fall, 1972, was the largest yet), we needed to investigate the dimensions of female attrition to determine if it was a potential problem.

When we attempted to assess the situation we found there was no suitable data at Cornell because we had not had sufficient females in the entering class to gather meaningful statistics on retention prior to 1971. Our situation at Cornell was hardly unique, as statistics were

not available for other institutions in the literature, and are still not available, except for a few isolated cases. The only approach feasible for the class entering in 1972 was to watch and to see if anything interesting developed. As a result, matters rested there until late September of 1972 when Sherri Koenig applied for one of seven positions on the peer counseling staff; her subsequent appointment turned out to be critical, for through conversations with her I began to glimpse what it was like to be a female in engineering.

Quantitatively, we did not learn much about retention from the class that entered in 1972. But through Sherri's work, and by being more sensitive to needs expressed by women who came to the Advising Center, we recognized that females often did not talk about the same issues that bothered males and we began to get a better qualitative feel for the various areas that seemed to be the source of trouble. By the end of the year, I was convinced that problems developed because females entering engineering differed greatly in their attitudes and expectations from their male counterparts, and in lunchtime conversations with Dave I argued that the new females were also vastly different from their female predecessors, which explained why we now saw problems we had not encountered before. He responded, however, that the fact that differences existed did not in itself mean that problems followed. I agreed, but countered that among the new group of pioneering females there was a sizable proportion who were not "pioneers" capable of the strains of invading a homogeneous, somewhat foreign, and at times, hostile, community. I believed the attrition that I noticed was the product of a poorly proceeding assimilation process.

When 1973 began we had not proceeded much beyond our lunch time theories. Once again we had the largest entering group of females ever, yet we still could not present meaningful attrition data (even though we were collecting it) because of the longitudinal nature of such a study, and we still did not have any "hard" data to substantiate my hypotheses, nor any means to gather data. Yet 1973 turned out to be the second crucial year because : 1) Cornell University joined the Co-operative Institutional Research Project of the American Council on Education, 2) female students organized an active SWE chapter; and 3) Dorothy Jackson, seeking a masters in education at Cornell, chose to study engineering women in her thesis work on occupational choice. The ACE survey showed substantially different responses for females and males in several critical areas, i.e. in the reasons cited for career and educational choices, the objectives considered essential, the statements of agreement, and the estimates of future activities. The responses were different enough that one could project problems simply by envisioning what would happen when persons with these expectations were thrust into a relatively homogeneous population and a homogeneous educational system that had different expectations. To this small body of data, Dot Jackson added many insights and observations--and a lot of encouragement to proceed.

Dave Johnson and I did proceed, by going to Dean Cranch early in the spring of 1974 in an effort to convince him to add a woman to the staff. Lest you become too skeptical, I'll add that our motives were mixed, as Dave and I both were seeking a little assistance with the admissions and advising function. Dean Cranch may have suspected this, since it didn't take long for him to steal our thunder. He praised us

for our acumen at ferreting out problems, he complimented us on our research to date, he appreciated our concern for students, and he asked us our opinion of what should be done--but he turned down politely our suggestion that a female be added to the staff.

There is no question he was correct in his approach, for we still didn't have the "hard" evidence we needed, and he didn't have sufficient contact with students to share our experiences and thus substantiate our soft "evidence." Having anticipated that we might not be successful in requesting a staff addition, we offered an alternative, namely, that the Dean allocate travel funds for us to visit six major engineering institutions to determine whether they were experiencing similar things with female students and to discover what they were doing about it. Dean Cranch agreed to the proposal and told us to go ahead.

Over lunch that day, we sat down to plan our travel schedule, only to discover that neither of us had the time to do anything that spring. In our anger and dismay, we hatched a new scheme, the Cornell Project on Women in Engineering, which was to consist of two parts: 1) a written survey of all engineering schools during the summer to discover the facts and figures on the enrollment, attrition, and retention; and 2) an attitudinal or psychological profile survey of all entering females and a comparable sample of males during Orientation week in August. The only problem that remained was to find time to carry it off, since we were already up to our ears in work.

That problem was solved four weeks later when I casually learned from Dean Burton that Mary Ott would be joining the staff in the Division of Basic Studies as a research associate, that she might be interested in our women's project and that I was free to interest her in advising women students. Happily, about three minutes after being introduced to Mary I knew our biggest problem was solved as she agreed to become the third member of our research effort. Now, a year later, we not only have a woman on the staff, but thanks largely to the efforts of Mary we also have a good collection of data which we have used to develop a tentative understanding of the problems confronting females entering engineering and the institutions who admit them in significant numbers. We hope you profit from our experience, and the experience of others, through this conference, and that you discover why we think it is important to invest your resources.

Robert E. Gardner

Robert E. Gardner received his B.A. degree in chemistry from Linfield College in 1966. After working a short period of time with Aerojet-General Corporation, he matriculated in the Graduate School at Cornell, where he completed work for a M.A. and Ph.D. in the History of Science. In 1971, he joined the College of Engineering as an Assistant to the Dean, and the following year was named Director of Advising and Counseling. In addition to administering the faculty advising system, he teaches "mini-courses" on the social implications of technology and on creativity in engineering; on the basis of a number of experimental

advising programs, he is currently instituting an integrated advising system for the College that will involve advising by professionals in an on-site location, a special engineering orientation course, seminar presentations by each discipline and an extended engineering experience during intersession. This integrated system, which is based largely on institutional research at Cornell, will include a special advising program designed to meet the needs of female students and to make the faculty and administration more aware of the needs of this population.

"The Chronology and Support of Educational Choices"
David C. Johnson

In the fall of 197-, seventy-three women registered in the freshman class (total 634 students) at the College of Engineering at Cornell University. As a part of Orientation Week activities, these women and a like number of men were asked to complete two survey instruments designed to gather information about student backgrounds, attitudes, and perceptions. Ninety students (49 women and 41 men) actually completed the surveys and a data base was developed on the responses submitted by forty-one women and forty-one men. Surveys completed by eight women were analyzed separately because of the students' minority status and the strong statistical bias that their responses had on the total population tested.

While the surveys were conducted in hopes of obtaining a wide variety of information about pre-freshman engineering students, the admissions staff of the College of Engineering was particularly interested in identifying the time frame in which most students finalize decisions regarding the choice of educational programs. In addition, the staff was curious to learn of the sources of and the degree of support expressed toward the students' academic and career choices as well as the relative importance of such support to the students' final commitment to engineering education. It was felt that such information could be helpful in the development of student recruitment strategies and equally important, in the design of student support activities which might be more responsive to the academic and personal needs of the contemporary engineering student.

Until quite recently, the typical engineering undergraduate was likely to be a majority male who exhibited an unusual affinity for mathematics and the sciences and who felt positively motivated toward engineering for both the nature of the academic work expected and the distinct opportunity for economic and social security without the protracted investment in graduate education required by the other recognized professions. With this type of student, motivation was not a pervasive problem of engineering education--or at least so it seemed. It was not until those efforts initiated in the mid-1960's designed to enhance the participation of racial and ethnic minority groups in all forms of higher education that engineering educators were made aware of the need to provide greater academic and career guidance for students not only at the collegiate level but indeed even as far back as the elementary grades.

Assuming for the moment that women share much in common with minority group members in terms of their historical isolation from certain educational and professional opportunities, officials at Cornell were particularly interested to learn if women registering with the class of 1978 (Fall 1974 freshmen) expressed a more natural, long-term preference for technical education or if such inclinations were the result of very recent deliberations and choices.

Accordingly, students completing the Cornell survey were asked to indicate when they first gave serious consideration to enrollment in an engineering curriculum. The responses to this question are reported in Table 1.

TABLE 1
Chronology of Decision-Making

	Variable: A	B	C	D	E	F	G	Row Total
Females (n=41)								
Number	2	1	5	9	13	11	0	41
% of n	4.9	2.4	12.2	22	31.7	26.8	0	100
Males (n=41)								
Number	4	2	4	11	15	3	2	41
% of n	9.8	4.9	9.8	26.8	36.6	7.3	4.9	100
Column Totals (n=82)								
Number	6	3	9	20	28	14	2	82
% of n	7.3	3.7	11	24.4	34.1	17.1	2.4	100

Key to variables A through G:
First serious consideration of Engineering as Possible Choice:

A. Before secondary schooling
B. During 9th grade
C. During 10th grade
D. First half of 11th grade
E. Second half of 11th grade
F. Within 8 to 12 months of Freshman (college) matriculation (first half of 12th grade)
G. Within the last 8 months

While the differences in the timing of such deliberations between women and men did not yield statistically significant results using chi-square analysis (p=.23), inspection of the raw data does lead to some interesting speculations. It is clear that the 11th grade (Columns D and E) and particularly the later half of that year (Column E) is the most important decision-making period in the career of the high school student. During that year, 54% of the women and 63% of the men surveyed first gave serious consideration to engineering education. It should be noted that the 11th grade typically includes coursework which for perhaps the first time, is somewhat illustrative of engineering education, e.g., advanced topics in mathematics and chemistry or physics. Equally important is the fact that the conclusion of 11th grade almost certainly requires the selection of senior courses which, again for the first time, may be truly elective in nature. The selection of courses like calculus, physics, or similar advanced coursework of a technical orientation not normally expected of all college-bound students perhaps solidifies a commitment for those students who earlier gave consideration to engineering education.

Prior to grade 11 (columns A through C), approximately 19% of the women and 25% of the men surveyed report that they first gave serious thought to the pursuit of an engineering degree. While both the number and percent of women indicating interest prior to grade 11 is small, it is well to remember that extensive recruiting programs aimed specifically at women did not gain full momentum until the academic year 1972-73--a period which is represented by columns D and E or grade 11. It is encouraging that nearly one out of five women surveyed (19.5%) first seriously considered engineering in advance of the extensive recruitment programs which now introduce women to engineering opportunities.

Perhaps the most interesting period of choice is the 12th grade (columns F and G) and particularly the first half (column F) of that year. Note that only 12% of the men surveyed indicated first consideration of engineering while 27% of the women noted that the fall of 12th grade was the time of choice. It is reasonable to contend that these women may have been attracted into engineering by the extensive new student recruitment programs active at Cornell and most major universities. The fact that over one-fourth of the female engineering matriculants last fall had not given serious thought to engineering education only twelve months earlier provides compelling evidence that engineering education has <u>not</u> yet become a well-recognized and recommended opportunity for the appropriately qualified secondary school woman. Furthermore, the disparity between the decision making of women and men in the 12th grade clearly depicts both the need for and the potential rewards of extensive efforts to encourage the technical interest of women. Until secondary school faculty, personnel, and parents become more cognizant of the viability of engineering for women, the onus of responsibility for the promotion of women as engineers must fall to engineering education. In time it is reasonable to expect that the decision-making pattern of women entering engineering may more closely approximate that of the men; less importance will be placed on the 12th grade as women make educational decisions and commitments at an earlier time. The congestion which characterizes the decision-making process of the contemporary woman considering engineering (80% decided within

the 15-month period represented by columns D, E, and F probably reflects the novelty of engineering as an educational and professional choice for a sizable number of women. Until such novelty is diminished and engineering becomes an acknowledged and recommended opportunity, the chronology of such decisions will continue to focus great attention on the 11th and first half of the 12th grade. For the time being, the data suggest that one woman in four entering engineering programs--at least at Cornell--had reached that decision within twelve to eight months prior to matriculation. If the latter half of the 11th grade is included, the number jumps to nearly six out of every ten female matriculants. While it may be presumptuous and somewhat unfair to suggest that the commitment of women to pursue engineering might be more tentative than those of the male counterparts, the relative lateness of the decision-making process leads to the speculation that such decisions might well require unusual support and encouragement if the woman is to realize her technical ambitions.

In order to learn more about the sources and degrees of support for the educational decisions of entering students, the Cornell survey instrument asked respondents to indicate the extent of encouragement or discouragement they received from parents, guidance counselors, and finally the admissions staff at Cornell. Contrary to the findings of Dr. Sandra Davis in her study of retention of males and females in the Institute of Technology at the University of Minnesota between 1960 and 1971, the Cornell data provides overwhelming evidence that the technical interests of women now receive the very strong support of both their parents and school counselors. Tables 2 and 3 detail the responses of the men and women surveyed with regard to the degree of parental and school support for the student's technical interests.

TABLE 2
Parental Support of Student Technical Interest

Variable:

	A	B	C	D	E	F	Row Total
Females (n=41)							
Number	0	2	7	12	13	7	41
% of n	0	4.9	17.7	29.3	31.7	17.1	100
Males (n=41)							
Number	0	1	6	16	6	12	41
% of n	0	2.4	14.6	39	14.6	29.3	100
Column Totals (n=82)							
Number	0	3	13	28	19	19	82
% of n	0	3.7	15.9	34.1	23.2	23.2	100

Key to variables A through F
Parents or Guardians Expressed:

A. Consistently strong discouragement
B. Consistently mild discouragement
C. Initially questioned technical interest, then supported that interest
D. Consistent encouragement
E. Consistently strong encouragement
F. Neither discouragement nor encouragement of technical interest

TABLE 3
Secondary School Counselor Support of Student Technical Interest

	Variable: A	B	C	D	E	Row Total
Females (n=41)						
Number	0	1	15	12	13	41
% of n	0	2.4	36.6	29.3	31.7	100
Males (n=41)						
Number	0	0	16	17	8	41
% of n	0	0	39	41.5	19.5	100
Column Totals (N=82)						
Number	0	1	31	29	21	82
% of N	0	1.2	37.8	35.4	25.6	100

Key to variables A through E:
School Counselor Expressed:

A. Consistently strong discouragement
B. Consistently mild discouragement
C. Neither discouragement nor encouragement, was largely unaware of student interests
D. Consistently mild encouragement
E. Consistently strong encouragement

Once again, chi-square analysis failed to produce statistically different response patterns (p=.30) between the men and the women; however, inspection of the raw data for the women depicts a markedly different pattern than that reported by Davis as characteristic of the 1960's. Note that in less than 5% of the cases the technical interests of women were even mildly questioned by parents; only one woman (2.4%) reported that her school guidance counselor expressed similar feelings. Over three-fourths (78%) of the women reported that support, ranging from qualified to consistently strong encouragement, was clearly expressed by parents. Absolutely no students indicated that they entered

engineering over the consistently strong objections of their parents.

Further inspection of the data on parental support seems to infer that, in general, parents seem to express greater interest in the plans and decisions of their daughters than of their sons. Note that only 17% of the women reported that their parents were seemingly unconcerned about their daughter's educational interests and presumably, their plans (column F) while almost 30% of the men surveyed noted a similar lack of expressed interest from their parents.

Like parents, school guidance personnel also expressed generally consistent support for the technical interests of their female advisees. Over 60% of the women noted that their guidance counselors at least offered mild, consistent support on behalf of the women's interests in engineering. Perhaps the most disturbing finding regarding the support or lack thereof coming from guidance personnel may be found in column C, Table 3, where it is noted that over 36% of the women and 39% of the men surveyed indicated that their guidance counselors were unaware of the students' particular interests and therefore could not offer either support or discouragement. The lack of interest and awareness which seemingly characterizes the school counselors, whether real or perceived, casts considerable doubt on the effectiveness to be expected of the guidance counselor as potential change agent in encouraging qualified women to consider and pursue pioneer professions such as engineering. Fortunately, the marginal effectiveness of the school counselor may be at least partially allayed by the fact that the students surveyed did not forego or alter their plans to pursue engineering education because of this lack of interest. However, the corollary to this situation is all too obvious; how many students, both female and male, are being deterred from pursuing engineering education, either overtly or covertly, because the guidance counselor is generally not in a position to assess a student's interests and offer sound academic and career advising? In short, for every three or four students engineering gains in spite of the guidance officer, how many does it lose because of the counselor's detachment from the development of students' interests and plans?

While both parental and school support must be considered important factors in the commitment of the adolescent woman to pursue technical education, according to the data, the encouragement of Cornell Engineering officials was cited as having an unusual bearing on the decision of women to enroll in an engineering curriculum. Highly significant statistical results ($p=.003$) were reported between the responses of women and men to questions designed to identify the effect that Cornell's encouragement or lack thereof had on the decision of students to pursue engineering. It is appropriate here to note that, in general, no major difference exists between the recruitment efforts of men and women candidates for Cornell. Therefore, the effective difference evidenced by the data in Table 4 is largely a matter of student perception rather than of degree of actual program.

TABLE 4

Importance of Institutional (Cornell's) Support to Student's Commitment to Engineering

Variable:	A	B	C	D	Row Total
Females (n=41)					
Number	11	15	11	4	41
% of n	26.8	36.6	26.8	9.8	100
Males (n=41)					
Number	1	11	19	10	41
% of n	2.4	26.8	46.3	24.4	100
Column Totals (N=82)					
Number	12	26	30	14	82
% of N	14.6	31.7	36.6	17.1	100.

Key to Variables A through D:

A. Very Important; crucial factor in decision to pursue engineering
B. One of many equally important factors
C. Not important, had no bearing on decision
D. Not applicable, feel that Cornell neither encouraged nor discouraged technical interests

The fact that 27% (column A, Table 4), of the women surveyed indicated that Cornell's encouragement was a critical factor in the decision-making process and that another 37% (column B) said that such support was one of several equally important considerations raises a number of provocative and perhaps even disturbing implications. The data suggest that the women were seemingly unsure of the technical interests and abilities and that the expressed encouragement of this institution, in whatever form, effectively assuaged those doubts at least to the point of convincing the woman to attempt engineering. Not so incidentally, precisely the same number of women citing the critical importance of Cornell's encouragement to their final commitment to attempt engineering also noted that engineering, as a possible educational and career choice, was initially considered in the first half of the 12th grade (Table 1, col.F). It is reasonable to expect that a strong, positive correlation exists between these two responses.

The differences between male and female response patterns as reported in Table 4 is dramatic. The women clearly attached greater importance to the responsiveness of engineering education, in particular Cornell, to their potential enrollment than did the men. The pursuit of engineering by women as expressed by freshman enrollment, is highly dependent on the perceived acceptability of the woman in the curriculum. On the other hand, the male student generally viewed the recruitment efforts of Cornell with relative detachment from his commitment to matriculate into an engineering program.

The focus of this paper has been somewhat contradictory to the program at hand--"Women in Engineering--Beyond Recruitment". While the thrust of this conference is to examine in some detail the academic, social, and personal development of the female in engineering beyond the point of freshman matriculation, such an examination requires some knowledge of attitudes and perceptions of the entering student.

In summary, beyond recruitment what may we reasonably expect from the first-year female engineering student? The results of the Cornell surveys present her as a student who only recently elected to pursue engineering and is unusually dependent upon external sources of support for her newly-developed technical interests. If engineering education is to maximize the participation of women in engineering, it must be sensitive to the patterns and perhaps uncertainties of female decision-making and the continuing need for reassurance and encouragement. Without the concomitant development of appropriate supportive student services, the simple recruitment of women into engineering cannot be expected to be the panacea for assuring the greater role of women in the engineering profession.

David C. Johnson

David C. Johnson is currently Director of Engineering Admissions and Financial Aid for the College of Engineering at Cornell University. In this capacity, Mr. Johnson has worked closely with female students and was instrumental in the efforts to establish a student section of the Society of Women Engineers (SWE) at Cornell in 1972. He has been responsible for development of annual engineering career conferences for pre-freshmen women which have been cited nationally as benchmark programs. In addition, he is active in a national consortium of engineering educators which seeks to facilitate greater female engineering enrollments and which fostered the founding of the newly-appointed (1974) Committee on Women of the American Society of Engineering Education (ASEE) headed by Professor Helen Plants. Mr. Johnson is co-director of the Cornell summer institute "Women Engineering Students--Beyond Recruitment." A 1967 graduate of DePauw University (Indiana) with a double major in English and economics, Mr. Johnson has undertaken considerable graduate study in Guidance and Student Personnel and Educational Administration at Cornell. His thesis, soon to be completed, will focus on the academic and experiential differences between freshmen women and men in the College of Engineering.

Attitudes and Experiences of
Freshman Engineers at Cornell

Mary Diederich Ott

In August, 1974, a group at Cornell began a research program to compare the characteristics of male and female engineers in the freshman class, and to follow students through their freshman year. The members of the research group were Robert Gardner, David Johnson, and myself, from the College of Engineering, and Florence Berger and Howard Kramer from the Office of the Dean of Students.

The year's activities began with the administration of a survey to the women freshmen and to a random sample of the men. Then the students who completed the survey were assigned to one of five follow-up groups for on-going activities during their freshman year. I will discuss the results of both of these aspects of our research program. I will begin by discussing the main results of the initial survey.

Initial Survey

The survey consisted of Part I of the College Student Questionnaire (CSQ) which was developed by the Educational Testing Service, as well as a 42-item instrument constructed by the research team. Part I of the College Student Questionnaire is a 200-item instrument which assesses student attitudes, high school experiences, and expectations about colleges and careers, and is intended for use with incoming freshmen. The shorter instrument developed at Cornell supplements the CSQ in the areas of recruitment, marriage-career expectations, and areas specific to Cornell, such as expectations of ones performance in a required chemistry course. All seventy-three of the female freshmen and a random sample of 82 of the 563 male freshmen were invited to participate in the survey. Forty-nine women (67%) and forty-one men (50%) completed the initial survey instruments at a special session during Orientation Week. The racial composition of the groups of males and females who completed the survey differed. No black men completed the survey. However, eight of the twelve black females in the freshman class completed the survey. Furthermore, the responses of the black women differed from those of the other women. For these reasons I have analyzed the data as a comparison of three groups:

(1) non-black males (n=41)
(2) non-black females (n=41)
and (3) black females (n=8).

I will compare the responses of the first two groups and then discuss those of the black women.

The survey results for non-black women and men were analyzed primarily by means of chi square analysis. These analyses indicated a large number of statistically significant differences ($p < .05$) between the responses of these two groups. In addition to recruitment, which David Johnson has discussed, the differences can be categorized into the following areas:

(1) academic backgrounds, attitudes and expectations
(2) extra-curricular activities and cultural interests
(3) field choice, work attitudes and academic goals
(4) family background and family dependence
(5) peer dependence
and (6) marriage-career preferences.

I will now discuss the nature of these differences.

In regard to academic background, attitudes, and achievement we found that women students were far more likely than men to have been at the very top of their high school classes. This high achievement appears to have been in part due to the fact that, on the average, women devoted more time to their homework than did men in high school. In fact the image that the female students convey is one of hard workers who wished to be remembered as brilliant students or as outstanding athletes, rather than as very popular students. Fewer women than men wanted to be remembered as very popular students.

A very significant result is the fact that men and women had different attitudes toward the high school subjects. 55% of women enjoyed math most of all their high school subjects, whereas 20% of women preferred science. In contrast, only 32% of men preferred math in high school, whereas 56% of the men preferred science. Furthermore, fewer women than men expected A's in their required college chemistry course, whereas there was no significant difference in the grade distributions expected in math. I believe these two results may be related to students' experiences in laboratory courses and may explain to some extent the differences between men's and women's field choices within engineering.

In regard to academic expectations, we noted further that 27% of the women and none of the men thought that faculty expect superior performance from women students. Moreover, women expected both male and female faculty and students to influence them at Cornell, whereas men did not think female faculty or students would be most influential in their lives at Cornell.

As far as extra-curricular and cultural interest are concerned, women were more interested in pre-professional clubs than were men, perhaps because women knew of the Society of Women Engineers section on campus. Women were somewhat more interested in religious, literary or dramatic activities as well as school spirit activities than were men. Furthermore, men and women had had different patterns of participation in high school activities. More men were active in hobby groups such as stamps or photography. Fewer women than men had participated actively in automotive activities although neither group of students has been greatly involved in these activities. A larger proportion of women than of men had participated very actively in musical performances. Finally, in regard to non-required reading, women were far more likely than men to prefer novels, short stories, drama, and so forth. These differences in extracurricular and cultural interest provide few variations from stereotyped male-female patterns.

The questions related to field choice, work attitudes and academic goals produced a number of important results. More men than women indicated an interest in mechanical or electrical engineering. More women than men were interested in civil or aeronautical engineering or "other". In addition, nearly half of the women and only twenty per cent of the men said they planned to work for a doctorate. As far as attitudes toward work are concerned, about half of each group preferred work in a medium or a large corporation. On the other hand, more men than women said they would like to have their own business or own office.

Men and women differed strongly on the most important source of future job satisfaction for themselves. Over seventy-five percent of the women indicated either that they wanted to be able to use their abilities or that they wanted to be helpful to others and/or useful to society. Although about a third of the men indicated that they would find it very important to be able to use their abilities, only two men indicated that they were most interested in being helpful to others or to society. Men appeared more interested than women in having relative freedom from supervision, prospects of an above average income, a stable, secure future, or freedom to be creative and original.

There were few differences in regard to family background. However, the mothers of 10 women and of only 4 men had graduate degrees. Women expressed closer ties to their families than did men. For example, more women than men said they would definitely not lose interest in their families due to absorption in some other activities. However, responses to a question concerned with perceived dependence on parents were mixed. Men's responses were fairly well distributed from "quite dependent" to "very independent" whereas a high proportion of women's responses were in the middle range.

In regard to peer dependence, the results are much more straightforward. Women indicated a much greater tendency than men did to consult with close friends about important decisions.

In regard to the marriage-career dimension, we found that men and women students misperceived each others preferences. As indicated in Table I, men thought that the women engineers were far more career oriented than these women students reported themselves to be (Questions 2 + 3). Second, women thought that men's preferences for their future wives would be far more family oriented than they were (Questions 1 + 4). Third, male student's preferences for their future wives' career involvement were significantly different from the women students' preferences for themselves (Questions 1 + 3). These results indicate that the male and female students began their college careers with important misperceptions about their marriage-career preferences. The misperceptions and the actual differences in preferences between the men and the women indicate a strong likelihood of future conflict in this area should these female engineers marry their classmates.

I will now consider the responses of the eight black women who completed the survey. These students were influenced by close friends in choice of field, and are strongly supported by their parents in this choice. The preference for math rather than for science was even stronger among black women than among the non-black women. All reported very

Table I

Responses to Marriage-Career Questions (Percentages)

Questions	Marriage-Career Continuum							
	1. Housewife only	2. Employed only before children are born, then housewife	3. Employed before children are born, and only after they are grown	4. Occasionally employed throughout marriage and child rearing	5. Combining marriage and child rearing with a part-time career	6. Combining a marriage and child rearing with a full-time career	7. Marriage and career, without children	8. Not married, only a career
FOR MEN								
1. Which one of the following situations would you prefer for your own wife? N=41	2	10	34	20	15	10	10	NA
2. Which one of the following situations do you think most women engineers prefer? N=39	0	0	0	0	28	54	18	0
FOR WOMEN								
3. Which one of the following situations would you prefer? N=41	0	0	27	2	15	39	15	2
4. Which one do you think most men engineers prefer for their wives? N=40	8	33	35	0	23	3	0	NA

close ties to their families. These students were very strongly in favor of a structured curriculum and assigned work and tended to be very anxious when taking exams. They were highly recruited by engineering colleges, but felt they would not be in the top third of the class at Cornell. In agreement with many of the other women, these women think faculty expect superior performance from women students and they expect to be strongly influenced by other women at Cornell.

Follow-up Activities

Shortly after the survey, all respondents were assigned to one of five groups. Group A was an all female group of 17 students who met periodically with two female members of the research staff. Group B was an all male group of 14 students who met with two male members of the research staff. Group C was a mixed-sex group of 15 who met with one female and one male member of the research staff. A mixed-sex group of 22 comprised group D. These students were surveyed periodically by mail. The remaining 22 students formed a control group.

The purposes of the group meetings for groups A, B, and C were to monitor the freshman year experiences of the male and female students and to compare the results of working with single sex and mixed sex groups. We learned that male and female students had many experiences in common during their freshman year. They started the first semester very optimistically, got bogged down during exam periods, and for the most part came through the year successfully. However, the different groups operated in somewhat different fashions. For example, the women's group became a type of support group rather than remaining a discussion group. The women's group and mixed-sex group both discussed the relationships between male and female engineering students, whereas the men's group included no discussion of these relationships, except for indications that some of the men had had no associations at all with women engineering students. Apparently the mixed group was a better vehicle for involving men in discussions about women in engineering than was the men's group. We did detect that some of the men resented the attention which was focused on women students in engineering.

The group which was surveyed by mail indicated clearly defined differences between the interests of the men and women in the group. For example, significantly more women than men considered the following to be important:

1) getting to know other students in class and outside of class;
2) finding some students helpful and sympathetic when they had problems;
3) finding that they could be themselves around other students;
4) finding faculty adequately accessible, and interacting with faculty outside the class setting;

and 5) having clear and specific assignments.

More men than women were concerned with coping with competition and pressure concerning grades.

These results tend to support the data from the initital survey which indicated that women acknowledged greater peer dependence than men did.

The final aspect of our research that I will report is the analysis of sociograms which some of the students constructed. We asked the 68 students in the discussion groups and in the group which was surveyed by mail to complete diagrams. 12 men and 9 women did so. Students were to draw pictures of themselves first and then affix symbols to the diagrams to represent each of their friends, faculty, family, and so forth whom they wished to include. The persons to whom the student felt closest were to be placed close to the symbol of the student.

We treated the completed posters as sociograms, measuring the distances from the center of the student to the symbol for each person represented on the poster. We then averaged the responses for each type of symbol separately for the male and female students.

Using nonparametric statistical tests, we found:

1) there were no significant differences between the sexes in degree of closeness to family members; and
2) female students were significantly closer to both their male faculty and their male teaching assistants than were male students.

Using chi square analysis, we found that friendship patterns for the men and women were significantly different. Women students tended to have a lower proportion of engineering students and of males among their friends than men did. This difference probably reflects the fact that women are still a minority in engineering and that the women whom the female engineers meet on campus are far less likely to be enrolled in engineering than are the men encountered by the male engineers.

The results of the sociograms indicate the importance of the relationship between male faculty and t.a.'s and the women students. In addition they imply that greater effort must be expended to establish peer support groups among women engineers than among their male counterparts.

Conclusions

As I have indicated, survey results, group meetings, and analysis of sociograms support the idea that men and women begin engineering studies with different attitudes and expectations, and that their freshman year experiences tend to differ. To briefly summarize: on the initial survey women reported higher achievement in high school than did men, more enjoyment of math than science, and somewhat more interest in religious, literary or dramatic activities than men. Men and women differed in choices of field within engineering and in the most important source of future job satisfaction. Family backgrounds were fairly similar. Women indicated greater peer dependence than did men. Men and women misperceived each others marriage-career preferences.

During the freshman year, we found that women students indicated more concern about interactions with other students than did men. Finally the sociogram results indicate that men and women had different friendship patterns, and that women indicated closer ties to their male instructors than did men.

I believe these results are very provocative, and can serve as a background for discussion throughout this Institute. I think that it is important to assess how generalizable these results are to other schools, and to consider their implications for engineering education.

Mary Diederich Ott

Mary Diederich Ott majored in physics at Seton Hill College in Greensburg, Pennsylvania. She obtained an M.S. in physics and a Ph.D. in education at the University of Chicago. She has been associated with educational research for the Division of Basic Engineering Studies at Cornell. Her research has included a study of male and female freshman engineering students, as well as evaluations of physics instruction and of the faculty advising systems at Cornell. In addition, Dr. Ott has served as a consultant to teaching assistants and faculty, and currently serves as an academic adviser to engineering students and as faculty adviser to the Society of Women Engineers section at Cornell.

THE NEW PIONEERS: WOMEN ENGINEERING STUDENTS

Engin Inel Holmstrom

I would like to think that one of the major contributions of the feminist movement has been the basic change in the career aspirations and awareness of women college students. Perhaps the relationship between the feminist movement and the increase in the number of women students entering fields previously undreamed of is not exactly a simple or direct relationship. But there is no denying the fact that the movement has caught the public eye, raised the consciousness of some, stirred the imagination of most women, voluntarily or involuntarily--as the case may be--changed the attitudes and expectations of male admission officers, and resulted in the opening of new vistas for women.

In the last couple of years, increasingly more women are venturing into so-called "masculine" fields. This year, some schools of medicine were shocked to see that three out of ten smiling freshman faces were feminine. Similar increases were noted in law and engineering schools.

The most recent statistics released by the Engineers Joint Council showed that there were 69 percent more women in the 1974-75 freshman engineering class than were in the previous year.[1] However, the use of percentages to show increases without referring to base numbers is often misleading: in 1973, there were only 2,443 women among 51,925 freshmen interest in engineering; in 1974, there were 4,140 among 63,444. In 1973, women constituted 5 percent of the entering engineering class, while in 1974, the proportion had increased to about 7 percent.

The engineering student body today is still predominantly male, but there are enough women around now to change part of its totally "masculine" image, and that, I think, is a healthy and long-overdue step.

Who are the women who venture into engineering classes? What are their backgrounds, qualifications, and aspirations? Will they be able to endure the minority status thrust upon them? The literature is rich with studies documenting the negative effects of unsupportive faculty, lack of role models, lack of peer-support, etc.[2] How can we help them?

I know this is the major focus of this conference here at Cornell and I am very grateful to the College of Engineering and its staff for recognizing the need for such a conference.

I do not know whether or not there are any sociologists among the group here in the audience, but there is something called a Hawthorne Effect in sociology which refers to an old experiment in a factory where a group of workers were isolated to test the effect of various environmental factors on their productivity. The environmental factors varied from different shades of wall paper, types of piped music, to variations in illumination. To the experimenters' surprise, the production kept going up, regardless of variations in the environment--even in the low illuminated situation where the workers could hardly see what they were doing. The moral of the story is that the identity of the workers as a chosen study group was stronger than any handicapping effect of environmental variables.

I would expect that the mere fact that Cornell is interested in recruitment as well as accomodation and retention of its women engineering students would have similar positive effects on everyone involved.

The data I will present today come from the American Council on Education's annual national surveys of first-time, full-time freshmen and are based on the 1972 freshman survey. The ACE data are weighted to approximate population parameters; in other words, the characteristics to be described are "national" characteristics applying to all first-time freshmen in 1972.[3]

The information described here is based on all engineering students (i.e., freshmen planning to major in engineering) and on a 10 percent random sample of nonengineering students. The freshman cohort is older than the one studied by Cornell; however, there is no reason to believe that the characteristics of students would change dramatically within two years.

A more serious factor reducing the relative comparability of Cornell engineering data and ACE data is that ACE data include students entering two-year colleges, as well as universities and four-year colleges. In fact, about 16 percent of the women in this study were enrolled in two-year colleges, 35 percent in four-year colleges, and 49 percent in universities. The comparable figures for men engineers were 42 percent in two-year colleges and 29 percent each in four-year colleges and universities. Since the number of women was small (only 2,252 as compared to 100,461 men engineering students), it was not feasible to present data controlling for type of institution. Thus, the age of the cohort,

the small number of women students involved, and the two-year college attendance rates should be kept in mind when comparisons with Cornell data are made.

Characteristics of Women Engineering Aspirants

Basically, the women who wanted to major in engineering among 1972 freshmen were younger and brighter than other students; came from a mid-income family with well-educated parents; had high academic aspirations, and differed from other students, both men and women, in some of their attitudes and life goals.

More specifically, nearly 9 out of 10 women engineering students claimed to be 18 years old or younger as compared to just over 3 out of 4 men engineers (Table 1). Women engineering students were also younger than were nonengineering women.

Table 1

Characteristics of Engineering and Nonengineering Students, by Sex

	Engineers[a]		Nonengineers[b]	
	Women	Men	Women	Men
(N)	(2,252)	(100,461)	(71,604)	(84,935)
% 18 or younger	88.5	76.4	82.8	73.1
% Black	7.5	4.3	9.6	7.3
Median Family income	$12,493	$12,534	$12,693	$12,605
% Father at least a college graduate	40.2	26.1	30.7	28.3
% Mother at least a college graduate	21.0	16.1	21.3	19.0
% Father an engineer	21.9	13.1	7.7	7.1
% Aspiring to B.A.	28.1	39.3	41.4	32.1
% Aspiring to M.A.	43.2	33.0	30.5	25.6
% Aspiring to Ph.D., Ed.D.	23.1	10.2	6.7	10.5
% High school GPA B+ and above	75.6	36.3	43.7	27.3

[a] All students aspiring to major in engineering among 1972 first-time, full-time freshmen.

[b] Ten percent random sample of remaining students.

The proportion of blacks among engineers was higher among women than among men: 7.5 percent versus 4.3 percent, a trend which is also observed among nonengineers.

The median family income of students was somewhat similar: $12,493 for women and $12,534 for men engineers, and slightly higher for nonengineers; the difference being $200 among women and less than $100 among men.

Although there was not much income differential, women engineering students had better educated parents. Fully 40 percent of women engineers had fathers who were at least college graduates as compared to 26 percent of the men engineers, and about 30 percent of others.

The difference in mothers' educational level was significant only among engineering students, with 21 percent of the women but only 16 percent of the men claiming mothers who were at least college graduates. It might be assumed that the high level of education among parents of women engineering students is related to their daughters' atypical career choice. Further, having a father who is an engineer was obviously important for women, with 22 percent reporting fathers as engineers as compared to 13 percent of men engineering students.

Research findings consistently show that women undergraduate students have better academic credentials than do men. Not surprisingly, similar results were obtained here: 44 percent of the nonengineering women but 27 percent of the men had high school grade-point averages of B+ or above. The academic background of women engineering students was even more impressive; 76 percent of the women engineers but only 36 percent of the men reported high school grade-point averages of B+ and above. Even more striking is the fact that nearly 3 out of 10 women engineers (28.8 percent) had A or A+ averages as compared to only 7 percent of the men. However, this large sex difference in the high school academic performance of students in the engineering group may be mostly due to the larger proportion of men enrolled in two-year colleges. In a selective school like Cornell, such sex differences may be relatively reduced. Nevertheless, any sex difference in academic potential should not be overlooked as a possible problem source for students.

In line with their high academic qualifications, more of the women than men engineers were planning to get graduate degrees: 43 percent of the women planned to get a masters degree and 23 percent a doctorate as compared to 33 percent and 10 percent, respectively, of the men engineers, a difference which again may be due to the larger two-year college attendance rates of men.

Although the women engineers were younger, brighter, and academically more motivated, they were also more likely to be concerned about their ability to finance their college education: 39 percent of men but only 28 percent of women engineers reported no concerns regarding their ability to finance their education (Table 2).

The greatest financial source of support for all students was parents, but women engineers were less likely to receive parental aid than were other women students: 55 percent of the women engineers but 66 percent of nonengineers relied on this source. The corresponding figures for men were 52 and 55 percent, respectively. Because of their academic qualifications, 44 percent of women engineers were supported by scholarships or grants as compared to about one-fourth of all other students. Perhaps the availability of scholarship support was highly instrumental in attracting these bright women into engineering fields. Finally, among all students, men were more likely to rely on part-time summer work than were women.

Table 2

Financial Concern and Expectations of Engineering and Nonengineering Students, by Sex

	Engineers		Nonengineers	
	Women	Men	Women	Men
(N)	(2,252)	(100,461)	(71,604)	(84,935)
Financial Concern:				
Major	17.4	11.5	15.7	14.0
Some	54.9	49.7	49.9	49.9
None	27.7	38.7	34.4	37.0
Sources of Finances:				
Part-time or summer work	29.2	40.6	30.9	41.8
Savings from full-time employment	11.8	15.2	9.6	14.9
Spouse's employment	.6	2.1	3.1	2.7
Parental or family aid	54.9	52.1	66.3	55.2
Federal benefits from parents military service	1.5	2.2	2.6	3.0
G.I. benefits from your military service	---	3.8	---	4.5
Scholarships and grants	43.9	27.1	25.7	25.5
NDEA loans, fed. insured loans, or coll. loans	18.9	18.2	21.1	18.1
Other	6.3	5.9	8.4	6.6

Life Goals and Attitudes

Tables 3 and 4 present life goals and attitudes for these students. There are certain sex differences as well as differences based on field: that is, engineering vs. nonengineering.

Women usually tend to give less importance to financial considerations: for instance, only 30 percent of women but just over half the men rated the goal of being very well-off financially as very important or essential. More women than men rated helping others who are in difficulty as a major goal. Developing a meaningful philosophy of life was also a more important goal to women than it was to men.

There were also some interesting differences between engineers and nonengineers. For instance, within each sex, more nonengineers than engineers were likely to rate the goal of helping others as important or essential. Being successful in one's own business was more important to nonengineers than engineers; on the other hand, more engineers than nonengineers valued making a theoretical contribution to science as an important goal. This difference was quite striking among women with 23 percent of women engineers but only 7 percent of nonengineers endorsing the goal of making a theoretical contribution to science as essential or very important.

Table 3

Life Goals of Engineering and Nonengineering Students
(Percentage Endorsing Very Important or Essential)

	Engineers		Nonengineers	
	Women	Men	Women	Men
	(2,252)	(100,461)	(71,604)	(84,935)
Becoming accomplished in one of the performing arts (acting, dancing, etc.)	9.3	5.8	13.8	11.1
Obtaining recognition from my colleagues for contributions in my special field	37.1	38.4	32.3	41.0
Becoming an expert in finance and commerce	9.8	17.1	9.6	22.2
Having administrative responsibility for the work of others	17.0	28.8	17.4	28.6
Being very well-off financially	31.5	52.4	30.0	50.6
Helping others who are in difficulty	61.3	51.9	75.8	59.9
Participating in an organization like the Peace Corps or Vista	14.1	6.7	21.0	12.1
Becoming a community leader	11.2	11.8	11.6	17.4
Making a theoretical contribution to science	23.3	18.7	7.3	12.8
Writing original works (poems, novels, short stories, etc.)	9.5	5.7	16.3	13.2
Never being obligated to people	27.1	24.9	21.6	24.7
Creating artistic work (painting, sculpture, decorating, etc.)	18.0	7.9	22.3	13.8
Keeping up to date with political affairs	54.9	43.8	47.8	51.2
Being successful in a business of my own	28.8	50.3	33.0	56.2
Developing a meaningful philosophy of life	78.4	60.5	76.8	69.2

In line with their academic abilities and high aspirations, women engineers were more likely than the rest to give a high credence to keeping up to date with political affairs.

There were some interesting sex differences in attitudes regarding college rules and regulations. Women generally tended to be slightly more liberal or more radical than did men. For instance, fewer women than men agreed that college officials have been too lax in dealing with student protestors or that the college officials should ban persons with extreme views from speaking on campuses. Women engineers were the least likely group to agree that college officials had the right to regulate student behavior off campus or that student publications should be cleared by college officials. Women engineers were also the most likely group to insist that faculty promotions should be based in part on student evaluations.

Although they were slightly more radical than others in their attitudes regarding college life, rules and regulations, women engineers were less liberal when it came to such social issues as legalization of marijuana or helping disadvantaged students. Men tended to be more cynical than did women: they were more likely to agree that an individual can do very little to bring about changes in society or that the chief benefit of a college education was monetary. It is clear that some of the differences in attitudes and goals were based on sex; but in many ways, women and men aspiring to different occupations also had different backgrounds and expectations.

In summary, women engineering students, who are the new pioneers venturing into masculine fields, appear to be extremely bright, assertive women with high aspirations and quite radical views. Despite their resources, however, we might anticipate difficulties and stresses for these young women who are, after all, entering a field that has had a strongly masculine orientation. Any counseling effort directed at these women should keep in mind that these are not, necessarily, the type of students who could take paternalistic or patronizing attitudes easily but need to be given elbowroom and support rather than tight-structuring and direction. These women appear to have benefited from highly educated and supportive parents. It is important that their educational environment provides some means of continuity for adult support and encouragement. Although counseling may be a useful means, a more effective educational policy might be to ensure that appropriate role models are provided for these women.

Table 4

Attitudes of Engineering and Nonengineering Students, by Sex
(Percentage Agreeing Somewhat or Strongly)

	Engineers		Nonengineers	
	Women	Men	Women	Men
(N)	(2,252)	(100,461)	(71,604)	(84,935)
College officials have the right to regulate student behavior off campus	8.0	13.2	12.2	13.3

The chief benefit of a college education is that it increases one's earning power	49.7	70.8	51.8	65.3
Most college officials have been too lax in dealing with student protest on campus	42.1	50.8	39.1	44.9
Realistically, an individual person can do little to bring changes in our society	38.0	47.3	37.9	46.9
Marijuana should be legalized	40.6	43.8	44.2	50.8
Faculty promotions should be based in part on student evaluations	81.9	77.1	75.3	76.5
Student publications should be cleared by college officials	26.7	32.7	32.8	32.1
College officials have the right to ban persons with extreme views from speaking on campus	19.1	30.5	23.0	28.7
Students from disadvantaged social backgrounds should be given preferential treatment in college admissions	29.3	37.0	40.3	42.2

Footnotes

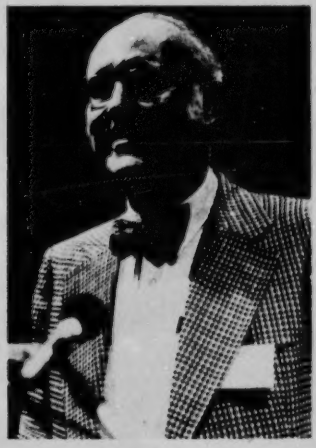
[1]Based on telephone conversation and May 1975 Newsletter, "Engineering Enrollment Show Sharp Upturn, Women and Minorities Make Major Gains," Engineers Joint Council, Engineering Manpower Commisssion, New York.

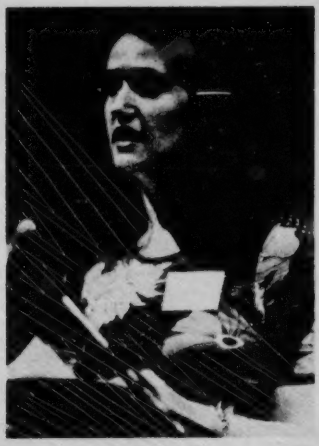
[2]See for example, Engin Inel Holmstrom and Robert W. Holmstrom, "Plight Of the Women Doctoral Student," The American Educational Research Journal, 1974, 11: 1-17.

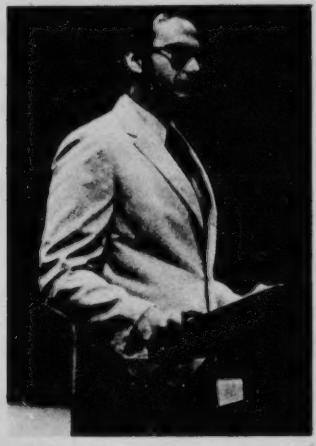
[3]For more detailed information, see John A. Creager, General Purpose Sampling in the Domain of Higher Education (ACE Research Reports, Vol. 3, No. 2, 1968).

Engin Inel Holmstrom

Engin Inel Holmstrom, Policy Associate with the Policy Analysis Service of the American Council on Education, received her B.A. at the American College for Girls in Istanbul, Turkey in 1951. She earned both her M.A. and Ph.D. in Sociology at Duke University. Her work with the ACE entails policy relevant investigation in higher education e.g., institutional characteristics related to the educational progress of new or atypical students, minorities, women and transfer students. Previously, she served as a research associate with the ACE Office of Research and with the Bureau of Social Science Research, where she was concerned with the educational development of women. From 1971-1973, Dr. Holmstrom was Chairperson of the District of Columbia Sociological Society's Task Force on the Status of Women in the Profession.







Session I: Questions and Answers

Judith Carberry: I'm very interested in the survey that you conducted about the freshmen engineers. I am the token woman on the teaching faculty at my university. I get harrassed by the male engineers about my activities with women engineers. I just wonder what the reception was to your work. You alluded briefly to objections to spending money and attention on women engineers. Could you describe that a little more fully as well as how you countered objections like this to the male faculty?

Bob Gardner: The reason I raised the question with which I began the conference was simply that I think it's a question that all these fifty institutions are now going to have to ask. Namely, how do you ask for money or ask for support from your dean? When he asks you "Why are you doing this for women?", how do you give him an adequate response? My answer is, you've got to get hard data before you can give him an adequate response because that's probably the only thing he believes in.

Fortunately, at Cornell there is enough institutional data available that you can make some pretty strong arguments. For example, for entering freshmen at Cornell, we have a Student Data Summary Sheet which includes a field choice for engineering. One can show, pretty quickly and pretty clearly, that the women do not select the same way that the men select. Since we're now in an economic crunch at Cornell, it becomes very important to plan faculty activities, field activities, because we have students in a general category for two years and then they disperse for two years. Thus, one point of leverage at Cornell has been that the Division of Basic Studies has certain data which are very important for planning purposes. If you can get the dean to agree that planning is a very important function in education now then you can also say, "Women are drastically different from men in many important planning respects, and you'd better do some research so that you know what's going on. Otherwise you're going to find that you need twice as many engineering faculty five years from now because you've doubled the number of women and you're going to need half as many electrical engineering faculty." That turns out to be a fairly important bargaining point.

Furthermore, the number of males in engineering has dropped. Whereas females were basically a fringe four years ago, that's no longer true. We're now in a position in which we can't do without females. So the dean really can't make the argument "What do we care about women?" I think that our success here has been not in trying to say "We ought to do this" for any moral reasons, but in trying to gather enough hard data to say "Just from an educational standpoint, we know this about women. We ought to know it about men too. But if you're going to plan now, if you've got all these problems we've got some data which you'd better consider. These things have long range implications, and if you're not ready for it, you're going to be in trouble."

Judith Carberry: But should women choose engineering for different reasons than men do? My male faculty colleagues say "Well why are they different? Why can't they make their choices in the same way that men do?

Bob Gardner: One of the things that needs to be done right now is to start an educational program for faculty members. Next fall at Cornell we will be going to each of the departments at Cornell and presenting our research data to the male faculty members. We don't want to have a male faculty adviser, for example, talking to a student about what field to select in terms of money, which she doesn't care about, prestige, which she doesn't care about and talking nonsense to this other person. We want both sides to understand each other. Somebody in each institution is going to have to take responsibility for these kinds of educational programs. In order to convince the faculty, you're going to need the hard data. It doesn't do any good to say "Well I talk with women engineers every day and they tell me thus and so." These men don't talk to women students, they don't hear it and they don't believe it. We regard the collection of the data at Cornell as possible leverage for everybody to use. And we're quite willing to share it. You can say, "We have to have a peer-support group. We need money for it. I can show you in black and white that the males don't need it but the females do need it." So we hope that one thing that will come out of the conference is this kind of a data base to give you the ammunition to make the argument. The more philosophical question about whether women are right in choosing engineering I hope to address in the very last session. I think that's a key question.

Lora Liss: I'd like to continue that subject, and point out that there are severe limitations to what you're calling hard data. "Hard Data, Soft Data," is a very interesting paper by Jacqueline Weisman, a sociologist, that I heartily recommend to all engineers. It reverses the "normal" definitions of hard data. You're dealing now with what you're calling hard data, what the expectations, aspirations of women today are, ignoring the fact that there are tremendous other societal forces operating, such as Affirmative Action. And women are beginning to understand that there is a statistical "hard data" reality that their salaries are lower, their status is lower, their rank is lower. Even when they have the same qualifications, the same publications, the same rate of the other meritacratic criteria, presumably, they still are lower on the totem pole. As this begins to hit more women, that consciousness may change of disregarding the need for financial success and they may begin to realize that this has worked to their detriment. It may be the engineers, for instance, who first recognize that and decide that, since they are in such a hard data field, perhaps they should alter their requirements and their expectations. This might result in some unexpected changes.

Therefore, I don't think you should restrict your long-range planning to what you are calling hard data, just asking where women are now. I think you need a much more systemic approach. You need to be aware of some of the other phenomena that are occurring that may change their perceptions of themselves, even by the time they graduate. These are entering freshmen you're talking about, and we have seen tremendous dramatic changes in freshman attitudes in two year spans in some of the American Council on Education studies. I've been amazed at how radically their perceptions, their attidues have changed in 2 years. This could happen to these women, as the whole movement makes women aware that their lack of concern for financial reward, for instance is going to get them

that--second class status.

Mary Ott: I think that because we have been dealing with a group that has been growing and has been small in the past, there hasn't been a chance to do any kind of follow-up on the way these attitudes have changed. We do expect changes, but we haven't had the data base to use to see what changes occur. I know that we've given data that indicates how students feel the day they arrive at Cornell or a week later. We did a follow-up survey in the Spring to find out if changes have occurred especially among the women, but the data isn't back yet so I couldn't talk about it. We plan to do a national study to find out what the freshman attitudes are when they begin, then at the end of their freshman year and at the end of their sophomore year. We hope to get at some of the issues that you raised here.

Lora Liss: Yes, but that's still attitudinal. It measures only where people are now. It doesn't attempt to access some of these other societal pressures and how these may produce unexpected results. In other words, we need more of an attempt to predict what changes will occur, not just in attitudes, but also behaviors. And I'm suggesting, for one thing, a look at how we go about affecting our own institutions in terms of their long range planning. We need not be so restricted as to say planning is based on our need to know right now, or two years from now, where our faculty supplies are likely to be affected, if at all. Of course in most places the proportion of women engineers is still so small that that won't happen right now. Given the choices being made now, will that projection affect that supply in ten years?

We might consider what things are happening that may affect the situation so that women won't be staying just in the "soft" disciplines. Or, if they are interested in the human side of engineering, we're going to need some faculty available who can approach those things.

Bob Gardner: My first comment was directed at how you convince the dean you're talking to now. And I think, being a historian in part, you've got to recognize that you don't argue the same case to different people in the same way. Your point's well taken. I'm not sure, however, that it is a very successful tack to take in getting done what you want to do.

There is a very small amount of data available on this; for example, in his article in the New Engineer on female engineers, Kaufman talks about the expectations or the reasons one selects a career. He shows that, for students who matriculated in 1961, the women resembled the men very strongly. I think there are two reasons that could be: first of all, either the women who didn't resemble the men dropped out, which I think is probably what happened, or secondly, that in 1961 the women weren't nearly as radical as they are now. If you argue that way, then you see that we're talking about a whole new group of women students and different attitudes. That's a good possibility. But since we have not enough data from 1961 we can't really establish that that's so. If I wanted to argue today to the dean that women are drastically different than their counterparts five years ago, I couldn't do it, because I don't have any data on the women from five years ago.

Engin Holmstrom: I wanted to make two points. I think the '61 freshman is really not a meaningful group for us to deal with or even think about, because women, as was mentioned before, have really changed. And perhaps what has changed in women is not the qualities women had, the aspirations women had. Mostly due to the feminist movement and the incredible research findings that have accumulated in the last 4 years and our awareness of it, what has changed in women most dramatically is our perception of our male environment and the way we are being treated. It is not our qualities that have changed. I agree with what Lora Liss is saying and I also agree with the importance of having a data base. I think you're both right, but you cannot have a data base and do justice to it if you're not evaluating it with the total social milieu, and in terms of the dynamic forces that are acting on women right now. Our perceptions of how we are treated by our male colleagues, our male students, our male faculty, are not the kinds of perceptions we had when we were students or professionals in 1961. With data, you have a way of measuring that, tapping that and knowing how to deal with it.

Barbara Wilson: I wanted to address your comment on the attrition rate of women in engineering. You didn't give any statistics as to what the rate is. Do you keep track of where these women go? If a girl goes to the School of Science to study applied mathematics or physics, I wouldn't worry, but if she's going completely to the other end of the spectrum, I would be curious to know why. And what is the normal transfer rate as compared to the transfer rate of women in engineering?

Bob Gardner: There is no definitive data on attrition and retention of women in engineering. In fact, last summer, when we attempted to survey schools, what we found is that nobody has it. Nobody knows the answer. At Cornell, as I indicated, the reason that we got interested is simply that I chanced to get seven women in a group. Now, if it had happened when I assigned female advisees that those scattered among the thirty male advisers and the attrition was high, we never would have known it, because it would have been in single increments. Sandra Davis has shown, I think, that about 30% of the females completed engineering and about 40% of the males. Here at Cornell, I would say that our attrition rate is running about 33% for women over the first 2 years and it is almost precisely the same for males.

Where women go seems to be exactly where you're fearing. At Cornell, they go to 2 places. They go to the other end of the spectrum, namely the liberal arts. There's also a significant loss to the College of Agriculture and Life Sciences, applied fields. It's both ways. We have a lot of students, for example, who switch from Civil Engineering to Landscape Architecture. It's not really clear why.

Helen O'Bannon: Where do the men go?

Bob Gardner: The men just don't come in to talk to us. They never tell us where they go. One nice thing about working with women is that they do consult peers, they do consult advisers. Many males drop out. They take leaves of absence rather than transferring. However, we have losses of very qualified males to Arts and Sciences, people we really hate to

lose. But among those transferring out, most of the loss I see is what I'll call "good" loss. I mean it's appropriate loss.

The more important thing for what you're talking about is that there's now at Cornell a large influx of women from Arts and Sciences to Engineering. And that is totally new. We're gaining 12 to 15 a year now, which is greater than our losses among females.

Barbara Wilson: It seemed incomplete to only mention that the women were dropping out of engineering at what seemed to be a very high rate.

Bob Gardner: I would say that the important factor for us is that women leave for different reasons.

Irene Peden: I would like to mention a study that was done at the University of Washington some years ago. I think it might have been in 1964 or 1965. Someone in our freshman engineering department made a very small study, related to women engineering students and what became of them as engineering students. The sample was very small. What was found was that the women came in with very high performance records in high school. That has been noted here and it was the case ten years ago too. Both men and women freshman engineering students experienced difficulty getting oriented academically in their freshman year. The girls experienced a greater degree of it, whether it was a culture shock kind of thing or a lack of technical preparation in high school, I'm not sure. They experienced more discouragement, they took it harder. And, percentage-wise, more of them dropped out of engineering after that, although those who stayed made the same kind of normal recovery pattern, academically, as the male students. It seems that when he looked at the group that stayed in engineering and finished, he found that there wasn't any parameter that had been measured or could be sorted out that could explain it in a simplistic way. It was not their academic performance. There were some women with very high grade point averages, ultimately, who did not finish in engineering. There were some who just hung on by their fingernails and graduated. So we were not able to explain it in those terms.

Engin Holmstrom: In the literature there appear to be two trends that explain retention or attrition, whichever way you want to look at it, and also changes in study fields, which is another form of attrition for each field. First, these students who perceive themselves as atypical in their study field choice are more likely to change field choices than are others. For instance, once women who aspire to become physicians or engineers realize that they are very atypical they tend to change. Second, students whose academic credentials are not appropriate for a certain career choice tend to change. So in this case, perhaps, the fact that engineering in 1964 was a very atypical choice might have been influential in the high attrition rate for these women. Another thing I would like to suggest is that these women who venture into masculine fields have very high academic credentials and aspirations. They are highly motivated. I think whatever frustration an engineering environment produces in the freshman year is going to be much higher for the women because they have much higher academic aspirations. They expect much more and they're going to face faculty and

students who are going to expect much less from them. I think this kind of frustration is probably one reason why women drop out.

David Johnson: At Cornell, women in engineering have to study right alongside women studying such diverse topics as human ecology, agriculture and life sciences, industrial and labor relations, architecture, or what have you. It can be a continual source of frustration to all students and, I sense particularly to women, to have to work alongside students who are achieving markedly higher academic success at Cornell and seemingly putting in less time. This year I happened to have about ten female advisees. That seemed to crop up consistently throughout the year--that their neighbors next door studying human ecology or perhaps sociology in the Arts College seemed to be doing a lot less and getting a lot farther. I think that's a particular symptom we have to be aware of in a university setting. It may not be appropriate to an institute of technology setting where essentially the students are all going through with the same basic programs. But in a university setting I think it is a problem we need to be aware of.

Helen O'Bannon: I'm interested in why you're not following your students through their senior year and determing what impact being in an engineering program has on one's attitudes and expectations? Are there any data to suggest that the educational process itself brings men's and women's attitudes and expectations closer together as they reach their senior year?

Bob Gardner: We will follow this group through their senior year. We haven't in the past simply because there haven't been large enough numbers and because we didn't catch on quickly enough that this is something we ought to do. It needs to be done and we would like other institutions to join us. With this group we have a good base line of data and we should be able to say something meaningful.

Helen O'Bannon: Do you have any intuitive feeling about what your senior women are like compared to your senior men?

Bob Gardner: It's my point of view that the freshmen are markedly different than our senior women in their motivations. I don't believe that's a fact of being in the institution for four years. I believe it's a factor of our recruiting women now at the rate of 27% a year coupled with some effect from the Women's Liberation Movement. So I believe that essentially four years ago we got women who were like the men because they came for the same reasons--the job motivations, the security. We now get women for an entirely different set of reasons, and I think the two groups are different.

Joseph Nedrow: I have a response that's not so much a question but a follow-up to Helen O'Bannon's question. I'm Joseph Nedrow from General Motors. As an employer, I can see some differences in the past year between women engineering seniors and men engineering seniors. The competitiveness on the campus to get women engineers is very critical. And women are very specific in asking what we are going to do in the way of career planning and where they are going to be two years from now and

three years from now. Their questions are much more pointed. I don't know whether this is a result of effective counseling or just a matter of having so many choices. The companies that have been the most successful are those that can actually lay out a rather specific kind of career plan that shows not only a host of developmental experiences, but, tied with those experiences, some expectations of a job position or a level or some kind of an increase.

As a sidelight, I might mention some experience that we've had in some of our college graduate-in-training programs. We thought at first that, as we had a number of in-house programs, we would spread out the women so that there would be a representative in each of many orientation sessions. We found that this wasn't very effective. Some of our employee research people found that there was a critical mass factor; that if there were one or two women engineers in a group of several engineers, they were rather reluctant to ask questions or even to participate in the seminars. But when it reached a certain point where they found support in each other, a much more meaningful kind of an experience resulted and the feedback from the participants was much more positive.

Carol Hall: I'd like to speak a little more about this critical mass factor because I found this to be true when I was an undergraduate here at Cornell as a Physics major. I graduated in 1967, and previous to that time there were always a few women Physics majors per year, but they usually dropped out so that maybe one graduated. But it happened that in my class about six or seven women started out and about thirty or forty men. And this number was just enough for us to encourage each other and to stick together, so that by the end, the six women graduated and eight men graduated in Physics. It was a real big jump over the previous years. So I think that we have to pay attention to how many women we have in particular fields and to group them together and make sure they know about each other and even get them to be friends with each other in order to help them stay around.

Bob Gardner: One of the things we've discovered here at Cornell is again the critical mass factor. The women have said that in their dormitories they don't study together, I think because they're so widely scattered. So, a good strategy, if you have a significant number of women, is to at least cluster them in the dorms. Don't scatter them here and there. I'm not saying that you should concentrate them all together, but make sure that where there is one, there are five or six.

Athena Theodore: I'm a sociologist, but I would like to speak from under my other hat, which is as a woman's activist in the Women's Equity Action League. Could I just have a point of information? I did not hear you make any reference to Affirmative Action at Cornell. In what way was your charge related to Affirmative Action on this campus, in terms of the collection of data, the recruitment policy. . . and in whatever other procedures you have used?. . .

Mary Ott: It doesn't have any relation in any formal way to the Affirmative Action program at Cornell. The policy and the guidelines for Affirmative Action at the present time are from 1970. They are

strictly related to minorities and do not include non-minority women. However, as you see, there is a lot of interest in women students on campus. The number of women enrolled at Cornell is significantly increasing in all areas: in law, in business, in the Arts College, in engineering. So we're really moving as far as enrollment is concerned. This program is an effort to try to work with women students and to assist in this area, but it is not really tied to a formal Affirmative Action program at Cornell.

David Johnson: It might be helpful to say that Affirmative Action at Cornell is largely limited to the well-being of employees of the institution and doesn't focus on the needs of students. There is a separate program, called the Committee on Special Education Projects, which has been in existence here for ten years, that has focused on recruitment and support services for minority students. That does not include non-minority women. There exists no university-wide effort to encourage the recruiting of women undergraduate students.

Lilli Hornig: I would like to point out that I am on the program and my primary concern is with Affirmative Action. I'm sorry to hear, incidently, that Cornell is not doing active recruiting of women undergraduates under Affirmative Action. It's going to have to under Title IX sooner or later. As you all know, the regulations for Title IX are still in the works. I think they're going to be rather more far reaching in their impact on women students than the previous Civil Rights legislation, which has been directed much more toward employment equality. I'd like to comment if I may on a couple of the earlier points raised. I was very interested in the comment one of you made that perhaps one of the reasons for attrition among freshmen engineers, and I believe this applies probably to all women in science, is that in a diverse university they see their friends and neighbors getting by with less work, often with what seems like more pleasant work and getting better grades for it. I think this is a very real problem. I might point out that in a university like Brown which has a strong liberal arts tradition, as well as, at present, extremely strong science and engineering, you run into a somewhat further complication, which is that faculty in the liberal arts departments, which are harder pressed for funds than the sciences, are actively engaged in wooing students away from the sciences . . .I think it's a situation that exists in many universities. It will probably get worse as the fund situation gets even tighter.

Bob Gardner: We've found that even our faculty advisers may advise female engineers that they might want to try liberal arts. So it's not just the liberal arts faculty who are out there recruiting. Within your own ranks you may be having some problems.

Esther Lee Burks: We're beginning a study similar to the one you've done on your entering freshman women and men. In your follow-up study, are you going to relate behavioral measures to some of this attitudinal and expectational information, in the sense of people leaving school?

Mary Ott: We will have forms which people will have to fill out when they leave the field of engineering or if they decide to transfer. Students will be asked to indicate the reasons why they are transferring.

Working with people at Cornell, we're able to have programs, have follow-ups, have an on-going discussion group, but in this follow-up we'll be working with people at other schools as well, and so we'll only be able to have written measures. But we will follow-up on the people who decide to transfer and try to find the reasons for those transfers.

Esther Lee Burks: How about measures of achievement? For example, does this high motivation that we spoke of plus high frustration mean higher achievement, or does it mean they give up and leave?

Mary Ott: Well, we'd want to know that kind of information, especially for the people who leave, to see if they were leaving because of academic difficulty or because of preferences for another field.

Esther Lee Burks: I'll mention one other thing. Bill Bold at Purdue has an active research program and has, over time, followed minorities in engineering. He has found that you have to follow people for as much as ten years from the freshman year in order to really find out the end result of finishing college, finishing engineering, and so forth. It seems to me that here we're beginning something comparable on women in engineering and that something we might keep in mind is that long time span in follow-up.

* * * *

"A Constructive Approach to the Education of Women Engineers"

Mildred S. Dresselhaus

These comments will be confined to women engineers at the undergraduate level, because issues relevant to graduate and professional women are discussed elsewhere in this conference.

We can expect that over the next decade women will constitute a significant fraction of the undergraduate student body of the Engineering Schools. There are a variety of reasons for this, including a greater interest of women in pursuing serious careers, fewer career opportunities in the more traditional professional fields for women, relatively high salary, societal changes increasing the number of socially acceptable career options for women, influence of the Women's Liberation Movement, encouragement by the general engineering community, recruitment by the colleges. Now that women are coming to the Engineering Schools in increasing numbers, we must think of their education beyond recruitment, and consider how we can make them better engineers, and happier about becoming and being engineers.

In this paper, we identify a number of problem areas. This will be followed by an enumeration of approaches to their solution, which will become the subjects for the workshops following the formal presentations of this session.

Some of the major problem areas include:

1. Underrepresentation of women in class--this leads to additional pressure and anxieties, and discourages class participation for fear of appearing ignorant or incompetent.

2. Lack of self-confidence and lower self-image--this arises from lower societal expectations, and from the observation of women playing lesser professional roles than men.

3. Lower aspiration level--this problem increases at each successive professional level and relates to a lower self-image.

4. Fear of success--some women fear that success may cause them to lose desirability and attractiveness as women, thereby jeopardizing opportunities for marriage.

5. Not being taken <u>seriously</u>--many women students feel they are not taken seriously as students, in planning a career, and in being a professional.

6. Feeling "left out of the action"--women are often not included in homework problem working sessions, studying for exams, luncheon

meetings where decisions are made.

7. Feelings of isolation--fewer professional contacts are made. Many women feel that it is more difficult for them to develop a feeling of professionalism.

8. Being outside the "buddy" system--this limits employment opportunities, opportunities for advancement and promotion to managerial positions.

9. Need for best possible training--women can expect a more hostile work environment, greater demands on their time, both at work through "extra" assignments and at home through family responsibilities.

Yet the woman engineer is judged on the basis of her technical achievements almost exclusively. To succeed in today's environment, her technical competence must allow her to carry out her technical work more efficiently, in order to allow for the other demands that will be made on her time.

10. Need to develop laboratory skills. A whole session is being devoted to this important topic; therefore no further comment is given here.

11. Problems of the research environment. These tend to be more serious than in the classroom. Normal difficulties of a beginning research student are compounded by feelings of isolation, self-doubt.

12. Problems of graduate study. Women encounter more obstacles in graduate study than as undergraduates, because of increased social pressures, financial considerations, questions of commitment and motivation, inadequate preparation because of atypical educational patterns.

13. Need for role models. Women need to see by example that women can "make it" in engineering. Role models are also needed to provide advice on specific problems. Today there are inadequate numbers of women in engineering positions (at universities and in industry) which command adequate professional respect from male students and colleagues.

14. Combining career and family--this is a major problem area, and is treated elsewhere in the conference.

15. Sexualized relations--these present difficulties in the classroom which are compounded in the research environment.

A great deal can be done to overcome these barriers to achievement for women. In response to the workshop format of this conference, a list of approaches for their solution are given below as topics for discussion in the workshops.

Topics for Discussion

1. How can the various institutions (educational, industrial, government) provide a more encouraging environment for women engineers and engineering students? How can the educational institution provide women with tools to deal with negative attitudes, discouraging situations and not be deflected by them? Education in these areas is as much a part of the engineering education as are the technical studies.

2. How can women help each other to become and be successful in engineering? How can women lend support to each other to help the total be greater than the sum of its parts? How can increased peer support and role model support be accomplished? What can women do to get more encouragement from male professionals, colleagues and supervisors?

3. How can orientation and career counselling programs at universities help women develop a sense of direction and professionalism in engineering? We should discuss means for developing more interdisciplinary training opportunities in the engineering fields, and opportunities for entry into engineering at a later stage in the educational process. We should discuss the role of women professionals in carrying out such programs.

4. How can we get more professional role models as faculty members on the university scene, and in senior positions in industry? How effective has affirmative action been? Where do we go from here?

5. How can the interaction with secondary schools (and junior high schools) be increased to encourage more women to study mathematics and science? Discuss the role of women engineering students as missionaries to the secondary schools--as a way to get the job done, and as a way to educate the engineering student in socialization issues. Can the resources of industry be mobilized?

6. How can we educate our male colleagues to be more sensitive to problems facing women students and professionals?

Mildred S. Dresselhaus

Mildred S. Dresselhaus was born in Brooklyn, New York, in 1930. She received her A.B. from Hunter College in 1951, summa cum laude. From 1951-52 she was in England at Newnham College, Cambridge University. She completed her A.M. in Radcliffe in 1953 and her Ph.D. at the University of Chicago in 1958. Dr. Dresselhaus was a Postdoctoral Fellow at Cornell University from 1958-60 and then served as a staff member at Massachusetts Institute of Technology Lincoln Laboratory until 1967. Since then, she's been Professor of Electrical Engineering at MIT, where she presently holds the Abby Rockefeller Mauze chair. Her field is solid state physics and engineering. She is a consultant for various industrial corporations and governmental agencies, and is a member of the National Academy of Engineering. She and her husband, Gene F. Dresselhaus, have four children.

"The Problems Facing Women Scientists and Engineers in Academia--A Review"

Margaret E. Law

I should like to talk in general about the problems facing a woman who wishes to become a scientist or engineer, with particular emphasis on the present situation of Ph.D. women in academia. I will touch briefly on the situations of women undergraduates and graduate students, but I think the other speakers will deal with these more thoroughly.

I'm sure it is not necessary to tell this audience that even today, with all the upsurge of interest in women's rights, it is not easy for a woman to be a scientist.* Even if a girl perseveres with a scientific education despite all the discouragements of her friends, parents and teachers, she is likely to find that, once qualified, she will have to fight the various subtle and unsubtle forms of discrimination against her as she tries to gain recognition in her field.

The philosophy that science and engineering are male professions has been built into our whole social system, so that one might argue that the factors operating against a potential female scientist come into play from her very birth. Certainly any interest a young girl may show in scientific toys is usually discouraged--she is given dolls to play with instead!

This discouragement becomes more tangible during the high school years. In the past many of the top science oriented schools have excluded girls or admitted them on a more limited basis than boys, (and this trend still continues despite the fact that technically it is now illegal) and even in co-ed schools girls have been discouraged or, in many cases, not allowed to take science oriented courses.

Despite this discouragement a considerable number of high school girls do apply to undergraduate schools with the idea of majoring in science. They may apply, but in the past their chances of being accepted were significantly less than those of equivalent high school boys--particularly if they applied to one of the top science oriented schools. This was mainly because of the more strict admissions criteria which girls had to satisfy to gain admission, and of the policy in many private schools of a "quota" for female student admissions which was well below the number of male students admitted. In addition many special schools of science and engineering have been either closed to girls or viewed by them as "male" institutions.

Fortunately we are seeing an improvement in these admissions policies. The 1972 Higher Education Act (if it ever gets enforced) prohibits discrimination in admissions for public co-ed schools. Private institutions, which are often the prestigious science oriented schools, are exempt from this ruling; but I believe they are feeling the effect of public pressure and are beginning to eliminate "quotas". For example, next year Harvard/Radcliffe will change to an equal admissions policy. (Previously there was a quota of 2.5/1 male/female). Of course it remains to be seen how quickly this will affect the numbers of women

* Throughout the talk I will use the term "scientist" very generally to include engineers. From the point of view of the problems I will discuss there is really no difference anyway.

science and engineering undergraduates, since these will largely depend on the pool of applicants. Still, I think there is every reason to hope that as the numbers of girls admitted to undergraduate school increase we will see at least an equivalent increase in the number of women science and engineering majors.

It is clearly not enough just to let these numbers increase slowly; we must take positive steps to encourage girls who have the ability and interest to major in science. Again, at the moment they are up against the same social pressures and lack of encouragement that they met in high school. It seems that female undergraduates are frequently oriented towards acquiring skills that they are told will be generally useful, rather than preparing for a career in one field. (Thus they are advised to take courses in education, child study, languages, etc.).

But, while encouraging female students to think of their undergraduate training as leading to a life-time career, we should not ignore the complications that such a course presently involves for a woman--particularly in science. Frequently it may mean postponing marriage and a family for several years. Often at the end of her education she will find that the employment opportunities open to her are more restricted than those available to her male colleagues.

There are some obvious ways in which some of these problems could be alleviated. First, it should become routine to admit to undergraduate schools older women who wish to resume their education. In the same way it should become routine for a student with other responsibilities to pursue her or his education on a part time basis. In both cases we must make sure that equitable amounts of scholarship aid are available. Second, placement officers and advisors should make every effort to place the able woman student in a position which will lead to full use of her potential as a scientist. Of course--categorizing job openings on the basis of sex is now illegal, but one needs to do something more positive than that.

Surely a significant factor in the low number of women science majors is the present lack of female role models in science in the world at large and on our college faculties in particular. Young women will be encouraged to contemplate careers in science when they see about them successful women scientists. They are unlikely to feel comfortable--and may even feel like interlopers--in departments where all the faculty are men.

It is vitally important, then, that science and engineering departments make every effort to increase their number of women faculty members. . .and I will return to this point later.

It is interesting to look at the numbers of women who presently obtain their undergraduate degrees in science, and the number who continue on to graduate school and their doctor's degrees.*

---

* These numbers are for 1969-70, but I do not think they have changed significantly. The numbers in physics and engineering are so small that even large changes in numbers do not change the percentages that much.

SLIDE #1 (#'s B.S., M.S., Ph.D.) (Please see end of paper)

Although the numbers are very much lower for the physical sciences and engineering than for the biological sciences, a very clear pattern emerges. In most cases the percentage of Ph.D.'s who are women is down by a factor of about two on the percentage of B.A.'s and B.S.'s who are women. (In math it is a factor of 5!).

Why is this? Obviously one thing that happens is that a higher percentage of women leave graduate school with a master's degree instead of a doctor's. Various studies have shown that the attrition rate in graduate school is higher for women than men, and that the major reason for this is family responsibilities. I have not found data on how this rate varies with field, but my guess is that it is likely to be worse for scientific fields, where often experimental research demands long and erratic hours in the laboratory.

As with undergraduates, there are several ways in which some of the special problems of women graduate students could be alleviated. It should become routine for a student with other responsibilities to continue her/or his/ education on a part-time basis with equivalent financial aid but full university benefits. Maternity leaves of reasonable length should be allowed, with guaranteed readmission and resumption of financial aid. In the same way it should be routine to admit to graduate schools qualified older women who wish to continue their education after raising a family. The availability of convenient care centers would clearly help.

In fact, every effort should be made to help a woman graduate student find a solution to her problems; she should not be advised to take a masters degree and quit. If she becomes pregnant she should not be made to feel that she must choose between being a mother and a scientist.

But, in addition to helping the women graduate students already enrolled we must also encourage more able women undergraduates to apply to graduate school. There is no evidence that the scholastic ability of women B.A.'s and B.S.'s is any less than that of their male colleagues. Neither is there any evidence for the myth that the "graduate education of a woman is wasted, since once she has her Ph.D. she will only quit to have babies". A study by Astin has shown that 91% of women Ph.D.'s continue to be active in their fields, 80% of them without interruption.

Yet, in general, science departments are not taking their women graduate students seriously; the women undergraduates know this and are discouraged from applying. If we are to encourage more girls to become scientists the faculty and administrators of science departments are going to have to change their attitudes about the role of women in our society as a whole, and their expectations about the performance and future of women scientists in particular.

I am sure these particular problems will be discussed in greater detail in Session 6 tomorrow.

Well, supposing we solve all these problems in the science education of women--what then? It is obviously useless to encourage young

girls to become scientists or engineers unless we can provide equal opportunities for them in the professions. This is certainly not the case at the present time. Women are found in the less prestigious jobs, the smaller teaching colleges, the non-tenure ranks, and in general they are paid less than their equivalent male colleagues.

Most of the data we have on women scientists in the professions concerns women in academia; there is very little information concerning women in industry or government laboratories. This is not surprising in that (according to the recent National Research Council survey) about 90% of working women Ph.D. scientists and engineers are involved in education as opposed to business. (It is also true that, with the exception of chemistry and engineering where there is a slightly larger percentage in business, a majority of male scientists are also involved in education).

The representation of women on university faculties follows a significantly different pattern from that for men. For example, in 1971 in co-ed institutions women formed 31% of the student bodies but only 13% of the faculties, with a distribution ranging from 4% of full professors to 23% of instructors. Women are concentrated in such non-faculty positions as research associates and lecturers and they are severely underrepresented in high level administrative positions.

Let us look at this situation in more detail for two institutions--Harvard and Berkeley.

SLIDE #2 (% Women Faculty at Harvard and Berkeley) (see end of paper)

The figures speak for themselves. As you can see up until 1969-70 there had been no improvement at all over a period of 10 years at Harvard or 40 years at Berkeley. I believe there has in fact been some improvement in the situation since 1970, particularly in the junior positions. But the improvement is painfully slow and the numbers have no where reached the percentages of women in the Ph.D. pool. For tenured positions it is worse. At Harvard the number of women full professors has increased by over 300% since 1969--there are now about 10 instead of 3! (out of about 400 total).

These figures are, of course, for all departments, but it is interesting to note that these low numbers exist not only for scientific departments, where one might expect to find fewer women based on the smaller numbers of women graduating in science, but also for non-science departments where women have traditionally formed a large proportion of the student body.

We can go further and look at the situation in two very different scientific fields.

First of all, physics:

SLIDE #3 (Women Faculty in Physics Departments) (Please see end of paper)

This is based on 1971-2 data. Again we see the usual trend, more women in lower grades and at less prestigious colleges. Remember these numbers should be compared to the figures for the percent of B.S.'s in physics who are women--which is about 7%--and the percent of Ph.D.'s in

physics who are women--about 2.7%.

There is more recent data now available for 1974-5 and I have tried to pencil these in. It is interesting to see what changes have occurred. The most noticeable improvements are in the assist. professorship level at the "top ten" schools and in all ranks of the Ph.D. granting universities. These seem to have come about at the expense of the less prestigious four-year colleges. But these numbers are still very small compared to the total number of over 600 women Ph.D. physicists, and in many cases the changes are far from statistically significant.

Perhaps Physics is a bad field to choose as the statistics are poor. So let us look at departments of psychology where 44% of the bachelors degrees and 22% of the doctoral degrees go to women.

SLIDE #4 (% of Women in Departments of Psychology) (See end of paper)

Well, the numbers are indeed higher, but exactly the same trend is there.

Not only are women in the lower grades in academia but in general they are paid less than men.

As an example:

SLIDE #5 (Faculty Salaries) (Please see end of paper)

This slide shows the salary situation (in 1970) at two universities, University of Massachusetts and the University of Minneosta. In all cases the women's salaries are lower than the men's by about 10 to 20%. Of course these are for all faculty positions, not just science departments, and also one might hope that they are out of date in 1975. Unfortunately I do not have comparable data for 1975. But more recent data for women physicists in academia in 1973 still show a salary differential in favor of men. (In fact this was slightly worse in 1973 than in 1971, .87 as compared to .90). In addition the 1973 NRC survey gives an average salary of $21,000 for male Ph.D. scientists and engineers compared to $17,600 for female Ph.D.'s. (These figures include Ph.D.'s in industry as well as academia so we cannot compare them exactly). The NRC data also show that this salary differential exists even for the most recent graduates.

There seems to be very little indication then that we have made any progress recently with the salary question.

I hope these few slides have given some indication of the situation of women in academia. Much, much more data exists. In fact more charges of discrimination have been filed against universities by women than the total filed by all other minorities. More than 360 institutions have been charged with a pattern of discrimination; not one of these charges has been refuted in any of the subsequent HEW investigations.

There are several factors which affect the low representation of women in academia. One of these is recruitment policies: until recently few faculty positions were announced, and candidates were largely

identified on the basis of contacts between faculty and their (male) colleagues at other institutions, i.e., the "buddy" system. One of the positive results of affirmative action has been that positions are now more openly advertised. This is fine if a department is sincere, but often the position has been effectively filled before the "ad" is placed. Departments still need to actively recruit women, particularly from the less traditional areas where the qualified women will mainly be found.

In addition, many professional women may have to face the problem of nepotism rules which still tend to exist in some universities, albeit covertly. It is increasingly likely that a woman and her husband may wish to pursue careers in the same field. When both apply to a department where such rules exist, it is usually the wife who is excluded, or given a part-time or non-faculty position. Clearly, nepotism rules (both covert and overt) should be abolished immediately and replaced, if necessary, by conflict of interest rules.

But one of the main problems, in my opinion, is that most of the faculty rules in academia were written with men in mind. These rules favor a continuous career; women are penalized for interrupting their careers for a period of time. For example: probably the most important years of a scientist's career are the 5-10 post Ph.D. years when his or her reputation is established and tenure achieved. Unfortunately for a woman these years often coincide with the period when she may wish to work less than full time in order to raise her family. In fact it was once commonly accepted that women who wished to have academic careers would have to sacrifice marriage and a family; and even today many people assume this to be the case.

But women are less and less willing to make this sacrifice, and why should they? Universities must make it easier for women who wish to have both a career and a family. Age should not be a factor in academic appointments. An older woman who chooses to return to her career after raising a family should not be barred from appointment at the assistant professor level for example. Likewise, unpaid maternity leave of reasonable length should be available to non-tenured and tenured faculty without jeopardizing their chances of promotion. Most importantly--part time academic positions for both males and females should become a normal feature of academic life. Such positions should, of course, carry full faculty prerogatives, but care must be taken to see that they do not become associated only with women and therefore by definition second class!

Obviously our goals for the representation of women on the faculties of science and engineering departments must be realistic and based on the availability of candidates, but although in some fields the pool of qualified women is small, such women do exist.

For example, as I mentioned earlier, it is extremely important that each department with a Ph.D. program have a tenured woman professor who can serve as a role model and advocate for the younger woman. If you look at the pools of available women it is feasible that this could be achieved in almost all science departments by 1980, but this will probably only happen if tenured positions are set aside for women (and this is not likely).

To summarize, I think there are two types of problems facing women scientists and engineers in academia. First, we have to overcome the prejudices against women, so that they can compete fairly with their male colleagues within the present system.

But we have to do more than this. In the long term you cannot get away from the fact that women are different from men and that, at least during their childbearing years, their lifestyles are different. At the moment a woman scientist must conform to a system set up by men--for men, and unless she remains unmarried this can make her life very difficult.

Therefore, if we are to make science and engineering attractive fields for women, and if we are to enable them to compete equally with men in them, we are going to have to change many of the details of the present system of employment--and we should not be ashamed or apologetic about this.

I believe that women have as much to contribute to science as men, and that they should be given every opportunity to do so, without having to compromise their lives in other ways.

#1

% Of Degrees Earned By Women In The U.S. (1969-70)

FIELD	B.S., B.A. % Women	M.S., M.A. % Women	Ph.D. % Women
Physics	6.2% (329)	7.2% (158)	2.6% (37)
Chemistry	18.2% (2116)	22.5% (477)	7.7% (167)
Mathematics	37.6% (10,251)	30.8% (1,591)	7.4% (78)
Engineering	0.76% (338)	1.1% (172)	0.65% (24)
Biological Science	27.9% (10,514)	31.6% (1,844)	14.3% (469)
Psychology	43.7% (14,740)	38.0% (1,566)	22.3% (372)

#2

% Women in Faculty Positions

Title	Harvard		Berkeley	
	1959/60 % Women	1968/69 % Women	1928-29 % Women	1969/70 % Women
Professor	0.9% (4)	0.5% (3)	2.1% (3)	2.3% (15)
Assoc. P.	6.3% (8)	5.3% (8)	4.3% (4)	5.3% (14)
Assist. P.	3.9% (8)	4.2% (17)	16.2% (16)	5.0% (16)
Instruc.	9.1% (52)	8.7% (69)	23.1% (9)	18.9% (20)
Lecturer	12.5% (28)	12.3% (50)	28.6% (16)	29.5% (90)
Associate	4.3% (5)	10.2% (24)	37.5% (24)	29.1% (58)

#3

Status of Women Faculty in Departments of Physics

Type of College	Status	Number of men	Number of women	% Women
"Top Ten" Universities	Professor	330	2 (2)	0.6 (0.6)
	Assoc. Prof.	88	1 (2)	1.1 (3.1)
	Ass't. Prof.	109	1 (6)	0.9 (6.6)
	Lesser Rank	35	1 (3)	2.8 (4.8)
Universities	Professor	2208	23 (34)	1.0 (1.5)
	Assoc. Prof.	1334	24 (28)	1.8 (2.1)
	Ass't. Prof.	1324	27 (41)	2.0 (4.4)
	Lesser Rank	269	17 (37)	5.9 (5.8)
4-Year Colleges with Undergrad. only (743)	Professor	869	55 (27)	5.8 (4.2)
	Assoc. Prof.	635	33 (29)	4.9 (3.8)
	Ass't. Prof.	1013	56 (52)	5.2 (7.6)
	Lesser Rank	421	44 (27)	9.5 (9.0)

(Data from the Report of the Committee on Women in Physics, American Physical Association, 1972.)
( ) = 1974/5 data

#4

Status of Women Faculty in Departments of Psychology

Type of Position	Status	Number of men	Number of women	% Women
Full-Time	Professor	1116	81	7
	Assoc. Prof.	723	80	10
	Ass't. Prof.	912	158	15
	Lesser Rank	91	53	37
	Research App.	49	58	54
Part-Time	Professor	213	26	11
	Assoc. Prof.	171	34	17
	Ass't. Prof.	170	56	25
	Lesser Rank	422	204	33
	Research App.	46	40	47
Tenure	With Tenure	1781	219	11
	Without Ten.	1208	268	18

(Data from the Report of the Task Force on the Status of Women in Psychology, American Psychological Association, 1972. Based on 170 departments.)

#5

COMPARISON OF FACULTY SALARIES

Rank	Women's Salary as % of Men's Salary	
	U of Mass. (Amherst)	U. of Minn. (Twin Cities)
Professor	86%	88%
Assoc. P.	92%	86%
Assist. P.	90%	88%
Instruct.	94%	91%
Lecturer	76%	78%

Margaret E. Law

Margaret E. Law was born and educated in England. She earned her B.S. in Physics at the University of Birmingham in 1955 and her Ph.D. in Physics at the same institution in 1958. Her field is experimental elementary particle physics. Since 1961 she's been at Harvard University, where her present position is Lecturer and Senior Research Associate in Physics. Dr. Law is currently Chairperson of the American Physical Society Committee on Women in Physics and Editor of "Goals for Women in Science," published by Women in Science and Engineering, Boston.

"Assertiveness: Key to Achievement"
Sandra O. Davis

I can recall the cover of an issue of Psychology Today catching my eye in 1968. The cover showed a young woman, seated in a rocker, displaying a nearly finished needlework design. On the design ringed by flowers and stitched in bright letters was the word "Fail". The issue, of course, carried an account of Matina Horner's research revealing the tendency for women to fear success, or rather fear the consequences of success. Since that well-known research was completed, other individuals besides Horner have expounded on the various barriers and obstacles existing between a woman and her chances of maximizing her potential for achievement. Some of the barriers are internal to the individual, while others are external.

I don't intend to summarize the relevant research on women and the psychology of achievement. But I do want to look at specific barriers to achievement that seem relevant to the young woman who chooses to major in engineering.

In research I conducted dealing with the persistence patterns of women in engineering, I discovered that the women who persisted in engineering seemed to have everything working for their success. They were bright, they had outstanding high school careers, they had received rewards and recognition for their high school achievements, they came from large high schools, they did not have to find employment during their freshman year in school, they had the crucial support of family, friends, and boyfriends, and they had definite ideas about their future careers and lifestyles when they enrolled.

On the opposite side were the women who did not persist in engineering. Instead of success stories, many faced both internal and external barriers which worked against their persisting or achieving in engineering. (A brief aside: I do not mean to imply that the women who persisted faced no problems or barriers, but simply that the barriers proved to be more numerous and/or insurmountable for the non-persisters.)

Examples of external barriers faced by the non-persisting women were--a financial situation that forced the student to work during her freshman year; parents or other family members who actively opposed the choice of engineering; and societal attitudes and stereotypes that depict women in engineering as unfeminine, out-of-place, asocial or weird.

The list of internal barriers faced by women in engineering is

lengthy, but I have selected seven that seem especially important here.

The first barrier is an uncertainty about the choice of engineering which means that the individual's commitment to engineering is low and easily undermined.

The second barrier is a lack of self confidence in general which results in more time spent worrying than doing.

A third barrier is an individual's erroneous assumption that a woman has to be a superbrain to succeed in engineering. Translated this becomes, "If my grades are less than almost an A average, I don't belong here."

A fourth internal barrier is the fear of the consequences of success and especially a fear that a choice of engineering means no dates and no mates.

Fifth, fear of failure is another internal barrier which prevents the individual from trying her best.

A sixth internal barrier is an over-reliance on others to inform the individual when she's going well as opposedto her having internalized standards of success.

The seventh barrier and closely related to the former is an over sensitivity to social approval or disapproval. The result is the individual worries too much about what others think of her and her choice of engineering.

I suppose each of you could add to the list. I think we have already implemented some excellent programs to help individual students surmount these obstacles to achievement in engineering. I am speaking particularly of role model contacts, support systems of women students, printed materials that contradict societal misconceptions, and conferences like this that generate discussion of issues and enthusiasm for solutions.

But there is one obstacle that we have not met head on, which Elizabeth Janeway among others has written about. She feels that all women have to fight the compliant woman who lives within or the woman society might want to see--the secondary person, the programmed-to-please woman. Janeway says, "Realizing our potential begins at home in our own minds and hearts. It begins with the casting off of the crippling image of the past. We women are all hesitant to assert our value."

I have been involved recently with three of my colleagues in an endeavour that I think teaches women to both value themselves and assert themselves. We developed a course for college women entitled "Women: A Sense of Identity." The course meets weekly for either 5 or 10 sessions. One of our primary goals isfor the individuals to learn a specific behavioral skill--namely, assertiveness. But we stress other objectives as well. We want the women who complete our course to better understand themselves as women and the roles they want to play. We want them to experience and appreciate the support they can find from other women. And we want them to know their own wants, needs, rights

and goals.

Our initial research on the effectiveness of the course shows through both objective and subjective data that class members increase in self confidence and self esteem, become more self-aware and learn how to be assertive. I believe the course then assists an individual to understand and counteract the internal barriers that stand between herself and her achievement potential.

I think assertiveness training, through the attention the press has been giving it, is often misunderstood and misinterpreted. It is not the same as aggressiveness; it does not only apply to encounters with clerks or waiters; and it does not turn people into self centered, loud-mouthed, demanding bores. It does help individuals deal effectively with situations that are difficult for them to handle. From my interactions with women in engineering, I feel they often face situations in their academic or personal lives in which they could benefit by applying this communication skill. And an added benefit in handling difficult situations is an increase in self confidence.

The assertiveness training program I am proposing as a help to women in engineering is, as you can see, a broad effort encompassing much more than just assertiveness. I have not yet offered this course specifically for women in engineering, but I do intend to implement it this academic year. I will keep you posted on the outcome and am willing to share the specific course content with any of you who are interested.

I would finally like to add that I regret my being unable to attend this Institute. I hope the Institute is as exciting and productive for you as I imagine it to be.

Sandra O. Davis

Sandra O. Davis received her Ph.D. in Counseling Psychology from the University of Minnesota in 1973. She is currently an Assistant Professor in the Student Counseling Bureau at the University of Minnesota. Her responsibilities include personal problem and vocational counseling with individual students (particularly students in the University's Institute of Technology), consulting with the administration of the Institute on its programs pertaining to women and other students, and working with the Institute's women students. She teaches a course on assertiveness training and developed a role models seminar for women students in the Institute. She also recently formed an educational-consulting firm, Psyche, Inc. with three other women psychologists.

"The Female Engineering Student: What Makes Her Tick"

(or An Exploration of the Interaction of Intrinsic-Extrinsic Motivation and Rewards, as Perceived by the Female Engineering Student)

Paddy W. Gough

Needless to say, I had a touch of megalomania when I titled the paper--for to fully explain what makes us tick would be certainly the impossible dream; yet I am not an engineer, but a psychologist. . . and, since we are often seized with megalomania, I will take it from there.

Seriously, other than being a psychologist, I am a woman interested in women and am working to help all of us as women optimize our attributes; so, to this end, I work with the female engineering students at Georgia Tech.

Since motivation seems to be at some point that makes all of us tick, and since there has been much psychological investigation and exploration into what might be defined as extrinsic motivation and what might be defined as intrinsic motivation--and, since I am of the opinion that intrinsic and extrinsic motivation do not combine additively, but rather interact (as predicted by self-perception theory), I decided to interview some of the female students at Georgia Tech to examine this interaction pattern and its effect on their academic performance.

In 1970, Barry Staw and Bobby Calder (University of Illinois at Urbana-Champaign) designed a study on the self-perception of intrinsic and extrinsic motivation to test the interaction hypothesis more directly by manipulating both intrinsic and extrinsic factors as independent variables and measuring their effects on relevant dependent variables.

Research on motivation has frequently drawn a distinction between intrinsic and extrinsic motivation (e.g., Atkinson, 1964; Hunt, 1965; Koch, 1956; Young, 1961). If a situation contains a specific goal which provides satisfaction independent of the actual activity itself, behavior is said to be extrinsically motivated. On the other hand, if the activity is valued for its own sake and appears to be self-sustained, behavior is said to be intrinsically motivated (Young, 1961, p. 171.). Although this distinction is conceptually appealing, it raises difficult questions. There are two major problems confronting the account of any behavior in terms of intrinsic and extrinsic motivation (Cofer and Appley, 1967). The most serious is that the phenomenon is merely named, not explained. Labeling a behavior as intrinsically motivated begs the question of the theoretical nature of the process through which the behavior has become a motive. The second problem is that there are other theories which might plausibly explain the phenomenon. No doubt the most common alternative explanation involves secondary reinforcement. Secondary reinforcement refers to a process by which an originally neutral stimulus acquires reinforcing properties through its association with a primary reinforcer. In these terms, an intrinsically motivated activity is simply one in which the reinforcement value of the goal has associatively rubbed off on the behavior itself. Thus, it is difficult

to use the notion of intrinsic motivation beyond the descriptive level.

Although the status of intrinsic motivation as a psychological construct is unclear, they do argue that the concept is of considerable interest from still another perspective. Instead of asking what intrinsic motivation is and how it operates, it may be viewed as a perception on the part of individuals. That is, suppose that individuals attempt to label their behavior in motivational terms much as do motivational theorists. The seeds of such an approach have been developed by de Charms (1968) as part of his work on personal causation as an effective determinant of behavior. de Charms argues as follows:

> As a first approximation, we propose that whenever a person experiences himself to be the locus of causality for his own behavior (to be an Origin), he will consider himself to be intrinsically motivated. Conversely, when a person perceives the locus of causality for his behavior to be external to himself (that he is a Pawn), he will consider himself to be extrinsically motivated (1968, p.328).

For de Charms, the crux of the distinction between intrinsic and extrinsic motivation stems from the feeling or perception personal causation. Satisfaction derives from an activity which is perceived as intrinsically motivated because of our need to feel a sense of personal causation in our actions.

de Charms' ideas may be readily extended to a more general approach to intrinsic motivation by means of Bem's (1967a, 1967b, 1970, 1972) self-perception theory. According to this theory, a person infers his internal states by observing his own behavior and the context in which it occurs. Thus a person may label his behavior as intrinsically motivated under some conditions and as extrinsically motivated under others. The environment provides cues as to whether one's internal motivation is intrinsic or extrinsic.

de Charms' (1968) discussion of intrinsic motivation poses an interesting question. Common sense would lead one to expect that intrinsic and extrinsic motivation summate to produce satisfaction, and most organizational theories of job attitudes have made this assumption (e.g., Porter and Lawler, 1968; Vroom, 1964). However, de Charms argues that intrinsic and extrinsic motivation interact. Specifically, the introduction of extrinsic rewards for a behavior may decrease motivation rather than enhance it, because the rewards decreased the perception of intrinsic motivation. He also predicts, conversely, that motivation may be enhanced if a reward is withheld.

Several recent studies have tended to support the hypothesis that intrinsic and extrinsic motivation are not additive. Deci (1971) found that the introduction of contingent monetary rewards for an interesting puzzle solving task apparently decreased subjects' subsequent desire to work on the puzzles, while a noncontingent monetary reward did not (1972b). Clader and Staw (in press), however, have pointed out a number of methodological problems that render this work very difficult to interpret. Three other studies provide firmer evidence. Lepper, Greene, and Nisbett (1973) demonstrated that children who expected a reward for an

interesting task, playing with magic markers, subsequently played with the markers in a free-time situation less than subjects who did not expect the reward or who received no reward. Kruglanski, Friedman, and Zeevi (1971) showed that children who received an extrinsic reward rated the experimental task as less enjoyable and were less likely to volunteer for similar experiments. Finally, Ross (1973) found that preschool children given a salient contingent reward displayed less interest in a target activity than subjects in a nonsalient reward or a control condition.

Calder's and Staw's basic experimental task consisted of solving 15 jig-saw type puzzles. The manipulation of intrinsic motivation was accomplished by having the puzzles blank for one group of subjeects versus having interesting pictures on the puzzles of another group. Fifteen pictures were carefully selected from back issues of magazines (chiefly Life), mounted on a large piece of poster board, and laminated. There was considerable variety in the content of the pictures, ranging from sporting events to the President, and they all involved some unique point of interest. (To ensure high general interest for all subjects, it was found necessary to include three Playboy centerfolds). Subjects were interviewed regarding their perceived effort and whether or not they were motivated by external factors or whether each was motivated by his own "intrinsic interest in the puzzle task itself." The only significant result was a blank-picture main effect for extrinsic motivation. Subjects in the blank puzzle task always saw themselves as more externally motivated. This finding suggests that subjects may have been more aware of the effects of external factors on their level of motivation than intrinsic factors.

While the present results demonstrate the interaction of intrinsic and extrinsic motivation, it is not clear to us that such an interaction need always be obtained. A more prudent hypothesis might be that under some conditions self-perception may produce an interaction between intrinsic and extrinsic motivation. Consider a description by Woodworth (1918) of the phenomenon of intrinsic motivation.

> . . .while a man may enter a certain line of business from a purely external economic motive, he develops an interest in the business for its own sake. . .and the motive force that drives him in the daily task, provided of course this does not degenerate into mere automatic routine, is precisely an interest in the problems confronting him and in the processes by which he is able to deal with those problems. The end furnishes the motive force for the search for means but once the means are found, they are apt to become interesting on their own account.

Taking a lead from Woodworth, a convenient way of viewing the self-perception process is to assume that an individual performs an intuitive means-ends analysis of his behavior.

Different self-perceptions may result according to the effect associated with the means and the ends of an action. Intrinsic motivation can be attributed most clearly when the means are positive and the ends

are negative or neutral. Extrinsic motivation can be attributed when the means are negative or neutral and the ends are positive. When both are positive, the attribution may be unstable.

Now to apply some of this theory to the female engineering student. One interesting aspect is that every girl interviewed did state that salary--or expected salary--was a prime motivation in their career decision, and that, as a female entering the engineering profession, six out of ten stated that they expected to make at least $50 per month over the average income for their friends now in college studying in curricula other than engineering; all stated that they perceived high salary as a motivating end to make the strenuous means of study, long labs, etc., endurable.

When asked the specific question of what kept her going when things were especially strenuous, one girl quickly replied, "I wonder myself! I think I'm a freak", but added that she usually does think of the higher-than-average salary she expects to make and this is enough to keep her going. This same girl states that grades have always been important to her and that she would like to be chosen for membership in an Honor Society; yet, she has received no academic recognition or external award to date and maintains a 3.0 average in Mechanical Engineering. She also stated that making an A was the greatest feeling in the world. If Lepper and Greene paid her for her A's, are we to assume her thrill would be less? Of course not; this seems to be a case, similar to all the others, where the girls all stated they were pleased with rewards and recognition and did perceive these as strong motivators.

Deci has suggested that non-contingent and verbal rewards do not produce the interaction effect, but the evidence for this proposition is most ambiguous. Other properties of rewards are almost certain to be important, though we know that extremely large rewards may become dis-associated from the task or simply outweigh other factors.

The student interviewed with the highest GPA, 3.7, (a National Merit Scholar who has received many awards) stated that monetary rewards meant very little to her, but that it was extremely important to make good grades, offering support to the research trend; that dollars or pay are not so motivating as social reinforcement. When asked whether she would rather be on the Dean's list or recive a $100 merit award, she is the only subject interviewed who chose Dean's list over the dollars, and has been on the Dean's list six out of eight quarters in Chemical Engineering.

My interviews did bear out that the girls with the lower GPA's (under 3.0) had received less praise, less recognition, less encouragement from family, and yet were persisting out of sheer dedication to persist. A typical comment was, "Well, I've been here six quarters, I'm not going to quit now." So then we explore persistence, per se, as a motivator.

The 1970 IEEE Career Decision Report (Super, et al, 1970) had this to say regarding the persisters, or those students who remain in engineering, have backgrounds resembling those of the total entering group. That is, these students tend to come from lower middle class homes where the father is most often employed in skilled or semi-skilled work. There

are more working class parents in this group than are seen in other entering college classes. This entering group is likely to have a high percentage of male, white students. Although the high school performance of entering engineering students is generally above average, the high school records of the students who remain in engineering tend to be better than those of men who leave the field. Similarly, the college records of the engineers tend to be better than those of men who leave the course (Lewis, Wolins, & Hogan, 1965; Werts, 1968).

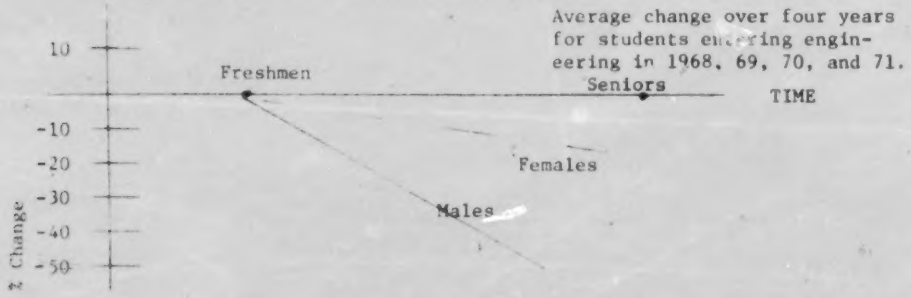
The personal characteristics of persisters show them to be high in ability, generally higher than those who transfer out of engineering. They are particularly good in mathematics, and their grades and performance in college have reflected this (Lewis, Wolins, & Hogan, 1965). The students who persist in engineering tend to have more stable interests than do those who transfer, and these interests are clearly in the technical and mechanical areas, focused on activities which are highly masculine (Abe & Holland, 1965a, 1965b; Gehman & Gehman, 1968). The engineers are intellectual and realistic in their orientations, interested in understanding, but with a focus on action. They are practical rather than abstract theorists. There is some conventionality in the make-up of engineers, with a preference for structure and organization rather than ambiguity in their thoughts and activities. Compared to other groups, the persisting engineering students are markedly removed from social concerns. They show a higher need for achievement than do those who transfer out of engineering. Engineers tend to value family over career to a greater extent than do other college student groups. Although they are interested in getting ahead, this is not as important as it seems to be to groups like liberal arts students and business students; they seek security rather than power or prestige, reflecting their working class backgrounds. Engineers see themselves fundamentally as men of action rather than as intellectuals, social reformers, or creative artists (Krulee, et al, 1966).

In the plans and expectations of engineers there is a real desire to achieve a standard of living higher than that of their own homes. They have come to college to gain professional skills, to find outlets for their intrinsic interests, and to achieve comfortable security. Upon graduation they plan to work as engineers, but they have in mind the eventual goal of moving to management (Krulee et al, 1966.) This plan to shift is even more pronounced among engineering seniors than among college students beginning their course work. The persisters see the ideal job as one in which they can make use of their abilities, and which will provide a stable and secure future. Persisters give more reasons than others for entering the engineering program. They have usually made this choice earlier than did the students who transferred out (Watley, 1965). They report the decision to make engineering a career to be their own to a greater extent than do the transfer students. In general, engineering students who persist are more sure of their choice to become engineers than are the students who leave the completion of the course (Van Erdewyk, 1968).

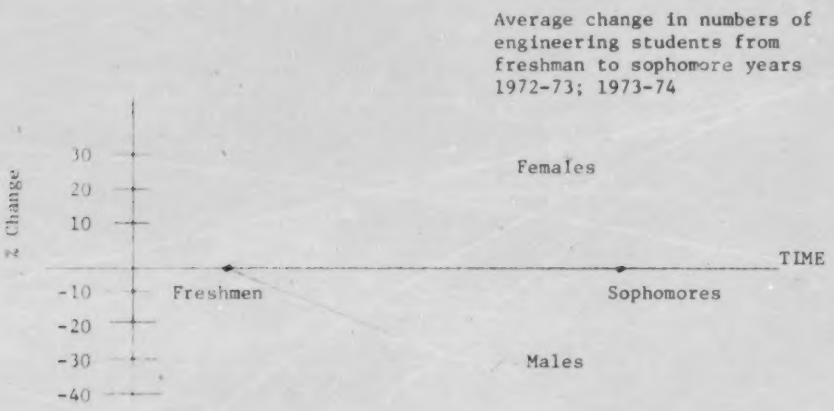
At a workshop last week in Colorado Springs, Lee Burks, also of Georgia Tech, presented data showing that female engineering students do tend to be more persistent than male engineering students.

Attrition Patterns of Men and Women Engineering Students

For the four most recent groups of entering students at Georgia Tech for whom four year patterns are complete--those entering in 1968, 1969, 1970 and 1971--the percent reduction in class size of male students follows a pattern that is also prevalent nationally. That is, there is an average decrease over four years in the number of male engineering students of 41%. (The national average is about 50%.) For women entering in those years, the decrease is about 12%.

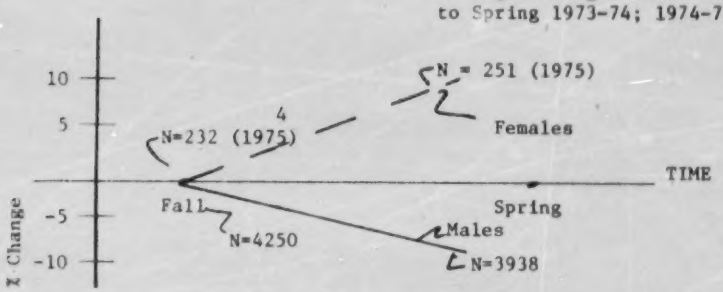


For the group of students entering engineering in 1972 and 1973, a period coinciding with the beginning of a special program for women in engineering, a rather different pattern seems to be emerging. For male students, the average percent change in numbers enrolled in engineering between freshman and sophomore year is a decrease of 33%. For women students, however, the change is an increase of 26%, reflecting, probably, a good retention rate for individuals entering, as well as some number of transfers within and from outside of the institution.



These data suggest a strong trend to persistance and/or increase in attractiveness of engineering for women students. Further evidence of this persistance is given by examining the changes in total numbers of engineering students between fall and spring quarters for the most recent two time periods. Traditionally, the total number of students at the institution decreases by several hundred. This is also true for students in engineering, who make up about half the student population. However, there is again a distinct difference in the patterns exhibited by men and women students. Men in engineering <u>decreased</u> in numbers by about 10%. Women in engineering <u>increased</u> in numbers by 10%.

Average Change in total numbers of engineering students--Fall to Spring 1973-74; 1974-75



<u>Conclusion</u> There is preliminary evidence that suggests that the woman in engineering is as likely, and probably more likely, to persist in engineering as is the male student. Also, it appears that the provision of a support system, in the form of a multi-faceted effort directed at recruitment, guidance, and research, is an aid in this positive pattern. There remain, however, many unanswered questions. The macro-pattern is encouraging; but it is not at all clear what is happening at the micro-level--the level of the individual student. Are women being recruited by creation of inflated expectations of what engineering studies will be like; and is this a temporary effect masking the disappointments and adjustments that could be the result of unrealistic expectations? In the Dean's office at Georgia Tech, we may see, on the same day, Janet, who rushes in to share the news that she made an A in the class with a professor who is known for almost never giving 'A's; and Ann, who enters crushed with the certainty that she failed physics again; and that this time she's going to be dropped from school. Both of these students have a dream of becoming an engineer--as did Susan, who confides that the school is just too technically oriented, too rigorous and no-nonsense for her to stay any longer. Which of these is the typical woman in engineering? Which of these stories will predominate in the long run? These questions remain unanswered.

In other research, Deci and Lepper, <u>et al</u>, have used persistence on a task as their single measures of intrinsic motivation. Nonetheless,

there are other indicators which can and should be utilized in assessing intrinsic motivation. Perhaps the most obvious indicator is reported task satisfaction, since one certainly should like a task if he is willing to perform it for no other apparent reward.

To sum it all up, it seems that the female engineering student is a special, persistent person, who is strongly motivated (both intrinsically and extrinsically) to attain goals that she perceives as positively rewarding. One coed responded, when asked why she remained when the going got tough, "Well, my dad drives a truck with a Tech sticker on the back and everytime someone asked him how his son like Tech, he beams with pride and says, 'My daughter likes it just fine'! and I couldn't deprive him of that happiness."

We all know that the curriculum is strenuous; we wonder why they do persist; and it is my hope that we will give all the encouragement, rewards, awards, and recognition possible to help them out.

References

Atkinson, J.W., An introduction to motivation. Princeton, N.J.: Van Nostrand, 1964.

Bem, D.J., Self perception: The dependent variable of human performances. Organizational Behavior and Human Performance, 1967, 2. 105-121. (a)

Bem, D.J., Self-perception: An alternative interpretation of cognitive dissonance phenomena. Psychological Review, 1967, 74, 183-2001 (b)

Bem, D.J., Beliefs, attitudes, and human affairs. Monterey, California: Brooks/Cole, 1970.

Bem, D.J., Self-perception theory. In L. Berkowitz (Ed.), Advances in experimental social psychology. Vol. 6. New York: Academic Press, 1972. Pp. 1-62.

Burks, Esther Lee, Attrition Patterns of Men and Women Engineering Students. Workshop on Retention. ASEE. 1975.

Calder, B.J. and Staw, B.M., The Self Perception of Instrinsic and Extrinsic Motivation. Faculty Working Papers.

Calder, B.M. and Staw, B.M., The interaction of intrinsic and extrinsic motivation: Some methodological notes. Journal of Personality and Social Psychology, in press.

Cofer, C.N. and Appley, M.H., Motivation: Theory and research. New York: Wiley, 1967.

de Charms, R., Personal causation: The internal affective determinants of behavior. New York: Academic Press, 1968.

Deci, E.L., The effects of externally mediated rewards on intrinsic motivation. Journal of Personality and Social Psychology, 1971, 18, 105-115.

Deci, E.L., Intrinsic motivation, extrinsic reinforcement, and inequity. Journal of Personality and Social Psychology, 1972a, 22, 113-120.

Deci, E.L., The effects of contingent and noncontingent rewards and controls on intrinsic motivation. Organizational Behavior and Human Performance, 1972b, 8, 217-229.

Hunt, J. McV., Intrinsic motivation and its role in psychological development. Nebraska Symposium on Motivation, 1965, 13, 189-282.

Koch, S., Behavior as "intrinsically" regulated: Work notes towards a pretheory of phenomena called motivational. Nebraska Symposium on Motivation, 1956, 4, 42-87.

Kruglanski, A.W., Freedman, I., and Zeevi, G., The effects of extrinsic incentives on some qualitative aspects of task performance. Journal of Personality, 1971, 39, 606-617.

Lepper, M. R., Greene, D., and Nisbett, R.E., Undermining children's intrinsic interest with extrinsic rewards: A test of the "overjustification" hypothesis. Journal of Personality and Social Psychology, 1973, 28, 129-137.

Ross, M., Salience of reward and intrinsic motivation. Manuscript submitted for publication, 1973.

Rotter, J.B., Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs, 1966, 80.

Staw, B.M., The attitudinal and behavioral consequence of changing a major organizational reward. Journal of Personality and Social Psychology, in press.

Steiner, I.D., Perceived Freedom. In L. Berkowitz (ed.), Advances in experimental social psychology. Vol. 5, 1970. Pp. 187-249.

Super, Donald, Martin J. Bohn Jr. and David Forrest, Career Decision Report, IEEE. 1970.

Weick, K.E., Reduction of cognitive dissonance through task enhancement and effort expenditure. Journal of Abnormal and Social Psychology, 1964, 68, 533-539.

Woodworth, R.S., Dynamic psychology. New York: Columbia University Press, 1918.

Young, P.T., Motivation and emotion. New York: Wiley, 1961.

Paddy W. Gough

Paddy W. Gough earned her B.A. in Sociology and Psychology from the University of North Carolina in 1959 and her certification for North Carolina Teacher's A Certificate in 1970 at Guilford College. She began work on an M. Ed. at the University of North Carolina in 1971 and completed the degree at Georgia State University, where she is presently

a Ph.D. candidate in School Psychology. As Assistant to the Dean of the Engineering College at the Georgia Institute of Technology, she is involved with all phases of college life, with emphasis on the academic, career, and personal counseling of women engineering students. A special part of her work has been in encouraging students to enter a Dual Degree program through which they would obtain both a Liberal Arts degree and an Engineering Degree. Ms. Gough has organized Assertive Training Workshops and is co-author of an upcoming book on the subject, Assertiveness: The New Alternative.

Session II: Questions and Answers

Laura Olson: I've been looking at statistics, and particularly the statistics that Margaret Law has shown...Engineering has traditionally been considered a male profession, yet so have others, such as Biology, pre-med, Physics, and so forth. Why do you think that engineering has always had and still has so much less in terms of percentages of women than these other so-called "male" professions?

Margaret Law: I can't tell you why, but as you go from the biological sciences and into the so-called "harder" sciences--Chemistry is in between, Physics is "harder", engineering is even "harder"--you get fewer and fewer women. And I can only hypothesize. One of the possible factors is that, in this country anyway, there is a myth about a woman not being able to do math. It's a typically American myth. It doesn't exist in Europe. Women have taken math in the past up to the bachelors level with the idea of teaching in high school. You see, there's a factor of five drop in the number of women students from the bachelors to the Ph.D. level in math, where there's a factor of two in the other fields. The only thing I can say is that in Biology you don't need any math at all; in Chemistry you hardly need any; in Physics you need a lot; in engineering you need a lot. Why engineering's worse than Physics, I don't know. It may be because more people go from engineering into industry. In Physics, a girl could think of teaching in high school, especially in the past, when a woman didn't have much of a goal for herself. In engineering you more often went into industry. Maybe that's the reason that engineering is worse than Physics.

Mildred Dresselhaus: Let me interject a conjecture. I think that it's part of our socialization process. In the Soviet block countries thirty percent of engineers are women. It isn't that they can't do it and do it in large numbers; it just hasn't been our tradition to do it, and it takes a lot to change a tradition.

David Johnson: I think one thing that might affect that is the environment in which all those subjects are studied. They are decidedly liberal arts subjects. Engineering is a college typically, that requires a commitment at the freshman level, whereas a Mathematics major may not have to make up her mind until the end of her sophomore year of collegiate study. And I suspect much can happen within the first two years of collegiate study to direct women toward fields which they might not have selected earlier. So I think there is a basic difference in the environment of study. Engineering is a four year commitment, typically, that is decided upon at the pre-freshman level. The other fields are distinctly chosen perhaps after a year of general liberal arts study.

Paddy Gough: One other thing I'd like to point out here is the importance of doing some counseling work in high schools. I've noticed that when the sophomore girl comes in the high school teachers and counsellors are prone to say, "Well, you probably won't need any more math." And then by the time the girl is a freshman in college and says, "Is engineering a possibility for me?", she's lost out on the math courses she needed in high school. It's my feeling that we need to start there, the sooner the better.

Mildred Dresselhaus: I'm not sure that the four year commitment is the whole story. Both MIT and Harvard don't start engineering in the freshman year, but they start it later on, and the percentage experience isn't distinctly different in this environment.

Christine Shoemaker: I majored in Math as an undergraduate and was in Physics for awhile. I now teach in the Engineering College, and I advise freshmen. I feel there are two major reasons for it, one of which is in line partly with what Dave is saying, not in the sense that they have to make the commitment so much earlier, but that the engineering curriculum is so restrictive. You spend so much of your first four years taking science courses. And it's not that women aren't interested in science and... mathematics, but they're more likely to also have interests in music, in art and so forth, and they resent, I think, not being able to take those courses more than men resent it. A freshman man is more job oriented and therefore finds the vocational orientation of an engineering program more appealing to him. I've had a number of my freshman advisees who seemed to be having second thoughts because of the restrictiveness of the engineering program. I also felt myself, in my own experience, that engineering was just so much more practically oriented. When it came to mathematics, I could do as well as the men could because it didn't depend on having any prior experience. When I went into Physics lab or any kind of engineering work I didn't know how to work with the machines. I didn't have any sense of how to work with all this equipment, which men did seem to have. That also discouraged me I know, and I think it probably discourages other women. I believe at Cornell there is a course in which they're trying to overcome some of that.

Lilli Hornig: I think I agree with almost all of these comments. I'd like to add one, which is that I think we have a peculiarly hard hat mentality to face about engineering that does not apply to the other sciences. Perhaps that's more immediately responsive to the question of why engineering attracts so many fewer women than the other "hard" sciences, some of which require possibly more complicated math. So I don't think it's the math disability. I do think the tool-handling disability is a real one. I've had to teach women in second and third year Chemistry how to use a screwdriver and in fact that there are several kinds of screwdrivers. This is a very basic kind of problem with women. I wanted to make a comment on Margaret's statement about the problem of women having to drop out, stop out, whatever, for personal or family reasons. Men, in fact, drop out and stop out about as often and for about the same lengths of time, for example, for military service, government service, or a sabbatical year, or two or three years consulting somewhere. This is always taken to be in their favor, whereas if a woman does it, it's just the other way around. Whatever she does, she's not addressing herself immediately to her profession....

Margaret Law: I'd just like to respond to a couple of things you said, Lilli. One, on the tool-handling business, I couldn't agree with you more. I think this goes back to what I said in the very beginning--you've got to go back to the cradle really. It's the social system. I remember when I was a little kid about five, I wanted nothing more than a railway train and I never did get a railway train set...You've really got to go right back to the beginning...And the second thing I'd like to say is that your point about men dropping out for military service is absolutely true. The difference used to be that if a man had to go into

military service his job had to by law be kept open for him. It wasn't so, but I think it's becoming so, for maternity leave. The other thing she didn't quite mention, but it's along the same lines, concerns my statement about part-time faculty positions for women and men. Effectively, an awful lot of senior men faculty are working part-time and consulting part-time. And that's accepted. But if a woman is working part-time and bringing up children part-time, it's not accepted.

Carol Hall: There's something that I've been wondering about. I'm wondering whether we're speaking about two different kinds of women engineers. The type of woman that Professor Dresselhaus described reminded me a bit of some of the older women, women like myself. That is the age group which was in school at the time when about eight engineers per year went through school. And this morning they were talking about 75 freshman women engineers. The two groups seem to me to be a little bit different and I wonder whether anybody could comment about that. I taught a course for women engineers this last semester, and it seemed to me that these women had very different ideas than I did. I thought they were similar to me, but they didn't seem to think they were.

Mildred Dresselhaus: I think there has been a major change. I agree with that. The change is on the university scene where the women are above critical mass. However, I think all the women students have to be aware of the fact that this above critical mass situation is just a university phenomenon. It won't be like that when they get their first job. Therefore, I think that in training women, we should keep in mind that they have to be prepared for the eventualities later when they will be in all kinds of situations where they may be very much outnumbered. Will they be able to find resources either from men or women elsewhere to get them over the rough spots?

Harit Majmudar: One request to the psychologist--that maybe you might like to do a study on how the male engineers tick and what motivates them to tick. I think it might make an interesting comparison. Maybe the findings might be somewhat similar. And the other thing is that we have a stereotype of engineering education, that is that everyone is going to wear a hard hat as an engineer. Engineering education itself is changing. For example, when I first talk to some of my classes I discuss what they are going to do and what engineers do after they go out from college. The chances are that maybe somebody will become a minister. Many engineers go into law school, medicine, and other things. So if you want to consider engineering as a broad based liberal education, then women and men both will go into it.

Dennis Shay: We have a special program at the University of Oklahoma in which we're trying to encourage girls to go into Physics. But if it's harder for women to get jobs than men, why are we trying to encourage girls to go into Physics? That is, what can you tell a girl who asks you what her prospects are in the future?

Margaret Law: Well this is a problem. What can you tell any student who wants to go into Physics?

Dennis Shay: Well I know what to tell a man.

Margaret Law: This is a problem that I often ask myself. All one can hope is that things will be improved by the time she's looking for a job.

I think for first jobs things are definitely improving. There's been a recent study by two men on the west coast which in fact is over-optimistic. I think they interpret it much too optimistically. They claim there's no sign of discrimination in universities in first jobs at all. But things are improving. And all you can say is that if they have the ability and they're interested, they should push ahead. You shouldn't encourage someone with mediocre ability.

Dennis Shay: The job situation is miserable for men. Now, is it any better for women?

Margaret Law: I don't think so.

Mildred Dresselhaus: I think it's somewhat better at the lower levels. I wanted to answer that in a different way. As far as women are concerned, the job opportunities in science and engineering, even in some of the so called "bad" fields, are better than they are in the traditional women's fields. And I think one really has to consider that. The job opportunities in Physics today are much better than in the social sciences and elementary school education.

Dennis Shay: But the thing is, when advising a girl to go into Physics, can I really justifiably say "You have an opportunity "?

Mildred Dresselhaus: Yes.

Margaret Law: You can say "You have just as good an opportunity in Physics as anywhere else, if not better."

Shirley Holmgreen: I just wanted to encourage you. You're going to be encouraging women to go into engineering and Physics and telling them that their opportunities are really very good. I think too you should warn them that while their foothold is fairly easy to get, they're still going to have problems once they get there, because right away they are in competition with men who are earning a little bit less because the women have the advantage right now. This means that they're going to have to produce more. Every time they're rated, they're going to be rated against these same men, and if they aren't better, then since they're earning more, there are going to be spikes on the curve. This is going to put them at a decided disadvantage. They're going to have to produce more, even though it's easier to get a job now.

Margaret Law: This business of earning more must be very specific to women engineersin their very first job, because it's just the reverse in other scientific fields and for people further up the ladder.

Shirley Holmgreen: It is a fact in engineering.

Session II: Workshops*

Groups dealt with the following areas:

1. How can the various institutions (educational, industrial, governmental) provide a more encouraging environment for women in engineering and engineering students? How can the educational institutions provide women with tools to deal with negative attitudes, discouraging situations so as not to be defeated by them? Education in these areas is as much a part of the engineering education as are the technical studies.

2. How can women help each other to become and be successful in engineering? How can women lend support to each other to help the total be greater than the sum of its parts? How can increased peer support and role model support be accomplished? The role of informal get-togethers should be explored. What can women do to get more encouragement from men professionals, colleagues?

3. How can orientation and career counselling programs at universities help women to develop a sense of direction and professionalism in engineering? Discussion of means to develop more interdisciplinary opportunities for training in the engineering fields, and opportunities for entry into engineering at a later stage in the educational process. Discussion of the role of women professionals in carrying out this program.

4. How can we get more professional role models as faculty members in the university scene, and in senior positions in industry? How effective has affirmative action been? Where do we go from here?

5. How can we increase the interaction with secondary schools (and junior high schools) to encourage women to study mathematics and science? Discuss the role of women engineering students as missionaries to the secondary schools--as a way to get the job done and as a way to educate the engineering student in socialization issues.

6. Is it difficult for women students to interact intellectually with graduate teaching assistants? If so, what can be done to improve the situation?

7. Do faculty attitudes toward women students need improvement? If so: What attitudes need to be changed? How can one work with faculty members to assist them in improving their attitudes?

8. Are you aware of women students having difficulties coping with being in the minority in their classes? If so: Which types of instruction exacerbate these difficulties, and which types alleviate the problem?

9. What programs are needed to assist women engineers academically? Do role models help? Has assertiveness training been utilized? What forms of motivation should be emphasized?

*Editors' note: Six workshop groups met. Each focused on one of the areas outlined in Mildred Dresselhaus' paper. Following the workshops, the group

Group IV dealt with these questions:

How can we get more professional role models as faculty members in university environments? How effective has affirmative action been? Where do we go from here?

The group initially centered its discussion on the purpose of role models. The role model serves two purposes. First, she demonstrates that women can be successful and can structure their lives. Second, she may occasionally serve as a shoulder to lean on, as an adviser about personal problems.

If role models are not available, other resources which are useful in increasing the identification of women students with the profession include a series of speakers, a semester-long visit of a woman scientist or engineer to the campus, video-tapes on successful women scientists, the film on "Women in Engineering" which was produced at MIT, and women's groups on campus or in the area, such as Women in Science and Engineering in Boston.

The effects to date of affirmative action were seen as fairly small, in part because many universities do not conform to accepted procedures. For instance, some schools do not list their openings nationally and do not treat male and female applicants equally. Inappropriate questions are still sometimes asked of women applicants, such as "How will you take care of your children?"

* * * *

Group V dealt with questions relating to the interaction with junior and senior high schools. The questions were:

How can we increase the interaction with secondary schools (and jr. highs) to encourage women to study mathematics and science?

Discuss the role of women engineering students as missionaries to the secondary schools--as a way to get the job done, and as a way to educate the engineering student in socialization issues.

Suggestions for increasing the interaction with high schools included:

Conferences for high school teachers and for high school students, and working with the National Science Teachers Association.

Women engineering students can go into the junior and senior high schools to discuss engineering, as can university and industry representatives. However, concern was expressed that the profession be realistically portrayed and that individual students not be deluged with recruiting materials.

* * * *

leaders summarized the outcomes of their discussions. Finally, there was an open discussion of the question of academic achievement which focused primarily on the needs of women faculty. Unfortunately, the reports from the group leaders and the general discussion were not recorded. For this reason, we have used the notes of the scribes for several of the groups in preparing this section.

Group VI

An attempt was made to raise the consciousness of the discussion group concerning subtle and not so subtle ways that male faculty members discriminate against women students. Anecdotes about the above were offered. One suggestion for improving male faculty members' awareness is for female faculty to discuss the issues with them on an individual basis.

*****

"The Social Scene: Isolation and Frustration"

Helen B. O'Bannon

By our presence at this Institute, all of us are involved with and concerned about young women who enter engineering schools. For a variety of reasons--from impacting sagging engineering enrollments to altering exclusive career patterns--many of us have tried to interest young women in engineering careers. We have worked to change admissions biases, to extend and extol employment opportunities, and to encourage young women to consider becoming engineers.

These functions, particularly the third, impose on each of us a tremendous responsibility. I believe we are aware of some of the implications only in a general sense. It is at Institutes like this one that we can define the components of that responsibility in detail. We are able to focus on several areas, examine the characteristic responses of female students, the barriers --academic, psychological, social and institutional--to their successful integration into an engineering curriculum and career and propose methods to accelerate the process with increased reliability, if appropriate.

My remarks today are based on personal observations--one could call it the arm chair data collection method. I have conducted no formal studies but I believe the area to be a potentially fruitful one for the serious social science researcher.

It is my contention that young women who consider and pursue an engineering curriculum today face an intricate socialization process. We must be aware of some of the facets of this process in order to be of real assistance. I believe the young woman entering engineering frequently faces severe conflict between her career goals and her personal goals. Societal norms still define engineering in "masculine" terms. We must understand these influences and norms as we work with women students to help them achieve congruence with their perceived sex role and their anticipated professional role.

Although I work in a College of Engineering my professional education is in economics. As an economist, I am interested in the efficiency with which the educational scene fulfills the needs of the market place. The demand for engineers continues to be strong even in a sluggish economy and predictions are that the demand for engineers will continue to be strong over the next five to ten years as we seek solutions to difficult social, technological and environmental problems and try to increase economic productivity. The demand for women engineers undoubtedly will outstrip supply for a number of years ahead. Hence, we should have little or no fear about that aspect of our encouragement of young women. However, if we encourage women to become engineers but do nothing to help them integrate this career with their self concept and personal goals, we will not be utilizing educational or human resources very efficiently.

I view higher education as an investment in one's human capital. According to human capital theory, an individual chooses that occupation and level of education that will maximize the present value of his or her expected life-time earnings. While an education and career in many engineering fields promise substantial economic rewards to the individual, the engineer must be comfortable with him or herself in that professional role in order to be truly productive.

I also assume that the cognitive skills and information acquired in college in fact do increase an individual's productive capacity. Some have argued, however, that the educational process merely serves as a screening device, selecting persons who already are more productive, rather than actually increasing their productive potential. Others, closer to my own viewpoint, have argued that the educational process does increase the productive potential, but the means are not clear. It may be that the educational process focuses on changing or developing affective rather than cognitive traits. Regardless of which side you are on, it is clear that the educational process does impact the individual's interest, attitudes and values.

One question that then must be asked and eventually answered involves the total experience of the undergraduate engineering student--particularly the female student. Do we, and should we, give any concern to the noncognitive domain of a female student's education? Should we pay more attention to the affective development of our students--specifically women?

It should be obvious that I am concerned not only with the acquisition of specific engineering skills but also with the development of the whole self. In the world around us we see society stress the importance of an individual's personal achievement, self control, independence and endurance of stress. One researcher, Herbert Gintis, has argued that certain affective traits that are correlated with academic success are also correlated with success in bureaucratic organizations. Moreover, these same affective, noncognitive traits are largely responsible for increased earning power of the more educated. Some of the traits Gintis includes, in addition to intelligence, are independence, inventiveness, self-assurance, and perceived occupational level or level of aspiration.

If these affective traits are important to an individual's success and job performance, then I believe we must be concerned about them in our female engineering students for they will impact their immediate academic performance and longer range future. Let us focus on the female engineering student's social values and examine how those values are reflected in her behavior as an engineering student. We can then discover areas in which this woman, even as a student, faces conflict between herself and her career ambition that may lead to frustration and social isolation.

Values are at the core of every human endeavor; they are the limits, the controls, the guideways. The values of any particular culture can tie its members together and produce a particular cultural pattern of responses. While not genetically transferred, values are a part of us. They are transmitted to the individual by the culture. Consciously and nonconsciously, the individual absorbs, adheres or reacts to the values held by the culture in which he or she has matured.

Our culture, for example, holds as values such notions as efficiency, profit, private property, economic growth, upward social mobility, education, right to work, various freedoms enunciated in the Bill of Rights, marriage and family, to name a few. These and other values mold our attitudes and beliefs; they mold our perceptions of events, of ourselves and of others; they provide us with a basis for our actions.

The Cornell data that I have seen and that are admittedly limited suggest that men and women entering engineering have distinctly different personal orientations and expectations from each other. Women seek strong intergroup relations and a capacity for enjoyment in both their private lives and their work. They seek more communal as contrasted with private experiences. They place a higher value on these aspects of a career than on the anticipated monetary rewards--although getting a job, per se, is important. In the McClelland scheme of needs, they have a higher need for affiliation than the male students.

With regard to personal, sexual roles, some very cursory data collected at Carnegie-Mellon by a student suggest women engineering students have a stronger desire for marriage and for family as juniors and seniors than female students in other disciplines. It would be interesting and valuable to know if this were also true for male engineers. Women engineering students also have a stronger career orientation; more envision a continuous career pattern rather than one interrupted by family obligations in contrast to other female students. The sample of students was very small and these results contradict some of my experience dealing with women who think they want to work, then marry and continue working, then stop working and have a family, and finally return to work. What is interesting from the data and my own experience is that the female engineering student today will have to consider managing simultaneously or by phasing both her career desires as well as her personal desires. She is not considering remaining single. Other studies of adult women engineers indicate that a very high percentage are married. To quote a far-out source, Erica Jong in her lively book Fear of Flying, has written:

> It is heresy in America to embrace any way of life except as half a couple. Solitude is un-American. It may be condoned in a man--especially if he is a "glamorous bachelor". . . .But a woman is always presumed to be alone as a result of abandonment, not choice.

These societal norms regarding marriage and family are accepted by most young people--men and women--entering college and I as a spouse and parent of four would have little credibility trying to urge students to consider alternatives. But why single out these norms and their impact on women entering engineering?

Women entering engineering have strong career aspirations and appear to have a somewhat stronger adherence to the established marriage and family values than their female peers. I believe that these values are not mutually exclusive, but they are difficult to integrate in a coherent, congruent self concept for anyone, and more difficult for women considering engineering. Suzanne Keller, professor of Sociology at Princeton who has looked critically at life patterns of women and men said:

"I doubt that one can be a mate, a mother and Madame Curie without being frazzled at the same time."

While it is true Madame Curie was a scientist, not an engineer, the point shouldn't be lost. I am stressing these two different values, because I believe that in the female engineering student today these cultural norms can result in internal conflicts which outwardly manifest themselves in a number of behavioral patterns.

At the freshman level today we are dealing with increasing numbers of women who are considering engineering but aren't certain. They are drawn to engineering because of employment possibilities at entry level after four or five years of college.

These women have received some objective measures of their intellectual and academic skills and talents. Undoubtedly, they are competent in math and science. To some extent they have already been filtered by the educational process. They are different if we are to believe the conclusions about the persuasive sex-role stereotyping of boys and girls that occurs in primary and secondary educational curricula. These women have talents and skills that are found more frequently among men.

Yet, these women are still adolescents, still in the process of discovering themselves. Accompanying this process of self discovery is the process of questioning, selecting, rejecting and modifying many previously accepted cultural values. They must select among alternative career roles--engineering is one alternative. They must select from among alternative personal roles--marriage being a possible and probable occurrence.

However, by having strong mathematical and science skills, these young women have acquired or developed what society considers to be more "masculine" skills. By even considering a career in engineering, a young woman takes another step in a direction that society has viewed as the exclusive purview of men. This move may result in increased conflict between her internal and external self; increased difficulty in reaching resolution.

What are some of the manifestations of this conflict--what are the implications for us here today?

In Matina Horner's widely quoted and frequently disputed study of "Femininity and Successful Achievement: A Basic Inconsistency" she identifies the fear of social rejection as one classification of her responses. While I don't want to dwell at all on her findings regarding the "Motive to avoid success," I have seen enumerable young women express what I would characterize as a fear of social rejection.

A young woman who was a freshman came to see me not long ago. She was doing well in her work. She was enjoying an active social life dating other people--many at first from her classes. She revealed however, that she was afraid to ask questions in her engineering classes. She said that if the questions were easy, she thought she would be considered stupid by the faculty and he would dismiss her as a serious student. If she asked a more difficult question that required expansion

and elaboration of a point, her male peers would think she was a brain and avoid her. Clearly the classroom had become an arena to her for the socialization process.

Another young woman had been ridiculed--often enough--by her male peers to ask if the faculty really did grade women easier than men. It seems her lab reports were consistently graded superior helping her overall grade in the course. The males were envious; they attributed her success to her sexuality rather than to her ability. On checking with the instructor, I found she organized her thoughts well, presented them clearly, defined the parameters of the experiment explicitly and logically reached the appropriate conclusion. Here was a student who was able, but had doubts about herself because she was a woman.

In both of these cases, the young woman student was concerned about her socialization in an unknown classroom arena. Women students see the classroom as a critical element in their social life and satisfaction. The feedback of her behavior to potential dates in the class itself is swift and direct. The fallout from her classroom performance to other potential social partners is quick and appears to the woman to have a toxic effect on her datability. The woman, because she may be the only female or one of only a few in the class, feels different, alone, and more vulnerable to this kind of feedback. I would contend that these women are not afraid of success, but are afraid that their male peers will reject them socially and this is of critical concern to most women students.

Women in engineering as those in other allied non-traditional career disciplines must also have some concern about their femaleness. There is a young woman engineer who said that she was at a party and was talking with a young man. When he asked her what she was studying, and she said she was in engineering, he turned on his heel and walked away, leaving her alone and wondering.

Many young women have asked me how they should deal with their male friends when they receive more job offers and better starting pay. The latter, if they are contemplating mariage, is a frequent problem today. The young women view their excellent earning capacity as an undermining factor in their relationships with men. What is frightening to me are the implications of these anecdotes. Women who are working toward a career and capable of attracting substantial financial rewards are ill-equipped to handle and resolve the interpersonal conflicts that result.

Some further observations may illustrate other aspects of this conflict. I have mentioned that women engineering students are more oriented toward marriage and permanent relationships than women students in other fields.

Another interesting pattern that I have observed is the comparatively higher participation rate in sororities by women engineering students than by other women on campus. Whereas twelve percent of female undergraduates beyond the freshman year were in sororities last year, about thirty percent of the women engineering students were in sororities.

I view this as evidence of a need for affiliation among women

engineering students. However, I believe it is of a certain kind. I think they select sororities because of the social reinforcement and access to more social interactions with men. Moreover, at Carnegie-Mellon, women engineering students steer clear of feminist organizations so one might conclude that their sorority affiliations are not designed exclusively to be with other women, but rather for the "normal" socialization and dating outlets.

It appears that women engineering students have a strong allegiance to academic honorary societies and fraternities. They frequently serve as officers--usually vice president or secretary. They are more active as a group in women's sports than any other group of women on campus.

On the other hand, they appear to avoid campus leadership positions. No woman engineer has been editor of the paper, yearbook or technical magazine. No engineering woman has been elected--or run--for student government or other major campus-wide office. This behavior has not been true of the male engineering students.

Perhaps it is unfair to make any judgments because women in engineering have been so few in number. It seems to me, however, that women engineering students have confined their activities to ones that reinforce the social interaction directly, or that are academically oriented. They do not seek positions of power or activities where they would openly compete with males outside of the classroom.

Another interesting characteristic I have noted is the apparent ease with which women in engineering identify themselves as engineers and refer to themselves in masculine terms. As advisor to the Association of Women Scientists and Engineers, I frequently hear them say, "O.K., you guys, let's vote." I believe that this easy identification as "one of the guys" is strong evidence of the dichotomy women engineering students face, that is, the dichotomy between the maleness of the engineering discipline and eventual career and the femaleness of their personal behavior.

In sum, women in engineering place high value on a career and they are also concerned abou their personal future. A very large proportion of women engineering students envision themselves married and having a family. To me more appear as seniors to have settled down with their future mate, but I have no other comparison.

Their behavior and articulated concerns as students suggest some anxiety over their femaleness. They appear to join organizations that promote social interaction and dating. They also join in community service activities. They avoid positions campus-wide or in the engineering community that are powerful; they avoid groups that are feminist. They do not want to appear assertive or aggressive as women.

Women engineering students are continually singled out as being different from the vast majority of engineers because of their sex, and different from the vast majority of women who follow more traditional academic disciplines because of their intellectual bent.

Being one of a small group following a path that appears to violate

society's norms is lonely. For the young woman still seeking a clearer definition of herself, the loneliness and isolation can exaggerate some of the internal conflicts she would normally experience at this period of her life.

If we view college as an important period in an individual's life, then we must be concerned about that individual. We must be aware of the dichotomies between a career path and private life that engineering may present for women. We must seek some short-term solutions to assist students to confront and resolve these conflicts realistically in order to achieve some harmony and congruence within themselves. I think we must be realistic when talking with prospective women engineers about the loneliness and isolation women face. I think we must alert young women to the possible frustrations they may face as students and as working women who seek both career and personal satisfaction.

In addition, more emphasis must be placed on affective development during college. We need to work in small groups with both men and women. We need to discuss openly their maleness and femaleness, their aspirations about combining career and family, the sacrifices that both men and women will need to make if they are to succeed.

Obviously having more women in engineering curricula will help. To this end we are all committed. Gradually, by increasing the number of women engineers some of society's values and stereotypes will change; many of the present conflicts will disappaear. What I believe our goal for the present should be is that we become aware of the problems today, seek ways to alert our women students to them, and finally to minimize them.

While none of us can eliminate the difficulties known and unknown that lie ahead for women students in engineering, we have a responsibility. We have urged them to take a different path. It is my hope that they will be able to say with conviction,

> Two roads diverged in a yellow wood
> And sorry I could not travel both
> And be one traveller. . . .
>
> I shall be telling this with a sigh
> Somewhere ages and ages hence:
> Two roads diverged in a wood, and I -
> I took the one less travelled by,
> And that has made all the difference.
>
> --The Road Not Taken, Robert Frost

Helen B. O'Bannon

Helen B. O'Bannon is Associate Dean of the College of Engineering at Carnegie-Mellon University where she is responsible for budgeting, financial planning and administration. She serves on a number of university committees concerned with affirmative action, student affairs and graduate student policies. She has taught at Robert Morris College and was a lecturer in Economics at Chatham College. She is co-author of Money and Banking: Theory, Policy and Institutions and a contributor to Readings in Money and Finance. Dean O'Bannon advises the Association of Women Scientists and Engineers and is actively involved in the recruitment of women into Engineering at Carnegie-Mellon University.

Session III: Response to Helen O'Bannon's Paper

Lilli Hornig: I've been a little undecided on what level to respond to Helen's paper. I find myself torn in at least two different directions and possibly more. I keep worrying a little bit that some of my responses and some others here are really our own old hang-ups that are already out of date. On the other hand, I know that that isn't quite true. It certainly isn't true everywhere. The statistical evidence that documents discrimination against women, most markedly in all the areas of science and certainly also most of engineering, is just overwhelming. What we don't know is what the current trend is. Where are we going right now? Changes are taking place very very rapidly. When you increase the number of women in freshman enginering classes ten-fold in the space of a year or two, you're dealing with a brand new phenomenon that is very difficult for us to generalize about. I think, to some extent, what we're seeing there is the impact of a much more activist feminist movement several years ago, when these young women were girls in junior high and high school and first began to see some new horizons opening up that they had not really considered very seriously before. It's my personal opinion that ten years ago, no matter how hard you went out and recruited, you just would not have found a hundred women engineers for any single class anywhere and evidently it's now being done at many schools.

What's interesting to think about is what's happened in the meantime to these young women. There are two words which Helen mentioned more than once: independence and self-assurance. I have no doubt that the young women in high school and college and graduate school now have a far greater degree of independece and self-assurance than certainly my generation or any other one probably up to 1966 or 1967. Helen was right. It is a frazzle to be a mate, a mother, and a Madame Curie. I think there's no sense in fooling anybody about that, but I don't think most of these people are particularly fooled. I don't think their expectations are that they're going to have a very easy life. I think what they're looking at is the long-term reward, both in personal satisfaction and, in some cases, monetary ways, for putting in that extra effort. I can tell you that you can be just as frazzled just staying home and being a mate and mother, in fact, perhaps more so.

I wonder whether some of our questions don't really originate in a skewed value system that we all are subject to. I keep feeling that one half of humanity can't be all wrong. If so many of us value certain things that apprently the other half doesn't value as much, what are we going to do about it? I think that's our real problem in engineering and the sciences and any other profession. I think, therefore, that the education and socialization of young men in this new world is going to be just as important as that of women. They're going to have to become used to, first of all, a new degree and type of competition that they have not had to face before. It's very nice to have the market all to yourself, but when you have only half, that's not quite so appealing perhaps. It seems to me there's just no question that, in one way or another, these young people are going to have to adjust to their mutual aspirations. I have no ready-made answers here. I think we've spent a lot of time in the last few years trying to explain the past. We've done that pretty well. My feeling is that it's time for new directions. I

think a conference like this can produce them. There are turning points that bring people together in a new way to think about old problems in new ways, and that's the kind of thing that I would hope would come out of the discussions here.

* * * *

Dr. Lilli Schwenk Hornig received her A.B. from Bryn Mawr College in 1942, magna cum laude with distinction in chemistry. She earned both her M.A. and her Ph.D. in Organic Chemistry at Harvard University. Presently she serves as Executive Director of the Higher Education Resource Services at Brown University. From 1966-1969 she was Associate Professor of Chemistry and Department Chairman at Trinity College. Dr. Hornig holds the Chair on the Committee on Women in Science and Engineering, the Human Resources Commission, and the National Academy of Sciences, and she is a consultant to the Agency for International Development, U.S. Department of State. Her contribution to a publication currently in press, Women in Academia, is a chapter entitled "Affirmative Action through Affirmative Attitudes."

Sheila Widnall: I was struck this morning by the data in the Cornell survey talking about the differences between men and women students. It reinforced my belief that the qualities which those women students have, say in contrast to their male colleagues, are something that the engineering profession needs very badly. I think many of us remember, although there may be some dispute about it, that during the Second World War the engineering professional was found somewhat lacking in the tasks that he had to perform. What this led to was a revolution in engineering curricula that emphasized a much higher quality of basic studies than had been the case up to that point. I guess today we have another revolution on our hands, and that revolution goes into the area of social responsibility and dealing with very complex systems. I believe that, for its own survival, the engineering profession must be a place which will make the women students which I heard described this morning feel at home. I think it's very unfair to place the burden on those women students to revolutionize the engineering profession. I see the engineering profession wrestling with the problem of developing standards on which to judge the individuals who are moving out in some of these new directions. And in that, I sometimes think metaphorically of a committee of dinosaurs sitting around trying to decide what traits they should develop in order to continue their successful evolution. They didn't succeed. . .The profession is going to profit enormously from questioning these basic assumptions and that's probably one of the reasons why I want to devote a lot of personal time and effort to this.

I'm the only woman engineer on this panel, and yet I'm one of those people who came through a long time ago and my personal experiences probably don't have a lot of relevance for the things that women students are experiencing today. I guess I would have been very frightened if somebody had tried to integrate my career goals with my social goals. I would have just said "Leave me alone and let me do what I feel I must do." I went into engineering with a great sense of its being an imperative. It was simply something I had to do; I had no choice. I felt I had these things and they had to be developed and there was no way to stop it and say "Well you know you can't do that because you're a woman." Being released at MIT in my freshman year was a little bit like being a cork suddenly released on the bottom of a tub of water. You just sort of shoot to the top, and I did that in a certain sense.

I'll give some personal data because I did all those things that people say women are going to have to worry about doing. I got a Bachelors degree and a Masters degree and a Doctors degree, and I have a husband and two children. I've never stopped working and I had all my children during finals so that I could get back and keep things going. I really like being a woman engineer. The thing I notice about being a woman engineer is the great heightened sense of awareness that you have. You know you are different from the people that you deal with all the time, and so you're always operating on a double level: I think the advantages far outweigh the disadvantages. I'm on the staff at MIT, and this year I've taken a position in the government where I have a budget of five million dollars to spend at universities on research on transportation. The thing that really blows my mind about being in Washington is that everybody there calls me "sir", and they do it without thinking and they do it all the time, consistently. "Yes sir, yes sir." It's really something. In engineering, like so many other fields, part of what you're trying to do is sell yourself. And being a woman is a great PR device since people remember you. So, basically, if you can deliver, then it's very easy to build a secure reputation.

The subject of this panel deals with isolation, so I had to do a lot of thinking to see in what sense I might feel isolated in the profession. . .I think there are, in some senses, certain ways that I feel isolated in my profession, and this might come about for four reasons. The first reason that I might feel isolated is that I feel I have a lot less time than many of my male colleagues, because I have a lot of family responsibilities, so that in terms of being frazzled, yes I'm somewhat frazzled. I think perhaps a reason I feel isolated is that I may put a greater value on personal relationships than a lot of my colleagues, so that I'm willing to devote more time and energy to personal relationships than perhaps a lot of them are. . .I find that my lifestyle differs significantly from my colleagues' in the fact that both my husband and I work. My colleagues are not typically in a situation where both partners are working. For that reason we don't get involved in a lot of rather standard kinds of faculty social activities because we have very little in common with the people that either one of us are colleagues with. For the most part these are engineers and they don't share a lot of the same things that we share. I think the last reason why women feel isolated is probably the most complex reason of all, and it's something that I've been wrestling with, and that deals with the issue of man-woman relationships. It is the case that most of my close friends are men; these are my colleagues. For me to want to have dinner with a colleague is a much more inflammatory situation for everybody concerned than it is for Joe and his buddy the chemist who works in the next office to decide they're going to play squash and then they're going to dinner and they're going to be home late. If I were to go to Joe and say "Let's play squash and then we'll go out to dinner and a movie and then we'll go home," that's a completely different scene, although it hasn't stopped me from developing quite a number of close friendships. But it still is an issue that I feel my male colleagues don't have to worry about. For me, being a woman is in some sense a disadvantage. On the other hand there is a certain delight on the other side of it, so I guess it comes out even.

* * * *

Dr. Sheila Widnall received her B.S., M.S., and Ph.D. from the Massachusetts Institute of Technology. Her specialty is fluid mechanics.

During the past academic year, she's been on leave from the MIT Department of Aeronautics to serve as Director of the Office of University Research, Department of Transportation. Active in women's activities at MIT, Dr. Widnall has worked with Mildred Dresselhaus in designing special courses to encourage women to go into engineering. This June, she will receive the Society of Women Engineers Distinguished Achievement award for 1975.

Martha Kopp: My comments are just going to be my experiences, starting with a little personal background. I'm an only child. I grew up on a farm with no neighbors, so I never had any contact with a lot of people and role castin . When I was in high school, I went to a small 250 student private school, everything was pretty much settled into cliques there. I was always a loner. I started dating in my junior year steadily, and got engaged. I went to Georgia Tech as an architecture student for three quarters and did terribly because I didn't have any art background. I got married that next summer and I just spent three quarters in the University of South Florida in civil engineering since it was the closest thing to architecture. I'm twenty years old.

Being a girl is a great thing at Georgia Tech. There were pretty few of us and the guys were very glad to have us there. . .Unfortunately I was the only girl at Tech that was associated with my husband's fraternity. I ended up eating there everyday for lunch and supper and it soon got to the point that I was one of the guys. . .

At the University of South Florida, the men all accepted me quite rapidly. I go to lunch with three or four male students quite often. One instance that I recall concerns a woman student who was on the Coop program. She was very upset because she had never met any of the wives of the people she was working with. They had a party at the end of the quarter when she was ready to go back and none of the wives were invited. It was as if they thought "Sorry, you're one of the guys, and you don't need to meet any other women. We don't think you'd be interested." It just went completely over their heads that she might be interested in meeting them.

Athena Theodore: I'd like to respond to a few points in Helen's paper, and then perhaps try to give some conclusions I have reached as to why these problems arise and then go on perhaps to discuss just a few strategies.

One thing that Helen spoke about was the masculine self-image that students have. I think, however, that students have pretty well come to terms with this masculine self-image before they reach college. We also ought to recognize that there will be personality differences in any student population. Boys are shy, sometimes the number does not make a difference. Many boys in a large male class will also not speak up, and so the reticence may derive from other than sex-related factors, i.e. academic competence or self-confidence or assurance, which may be a part of the person and not just socialization. What the student must deal with and we must deal with is the whole question of the marriage versus career syndrome. I hope we don't underestimate this. I've studied undergraduate students over twenty years now, and I can assure you that

marriage is very much the first preoccupation of our young students. Our surveys show us that increasingly young women are more concerned with their career. Their question now is, "How do you handle both marriage and career?" But that does not change the fact that there is a tremendous preoccupation among these young women as to what is going to happen to them marriage-wise. I see the social rejection and getting together in the sororities as one way of setting up defenses to deal wtih whatever problems they do encounter, whether they had to do with academic competence or competition or whatever.

We have not seen a great wave of feminism taking place among the undergraduate students. I do think, however, that the underlying support is there, that the movement is there and you can't help but see it in many ways. It's probably a good weapon at points where young women also use it for their own purposes. Maybe this helps them in their assertiveness. But they have not become assertive to the point where they have become feminists. On the other hand, the movement has helped them resolve some of their dilemma, so that now they can postpone marriage, they can have childless marriages, and they can have no marriages at all. . .

* * * *

Dr. Athena Theodore is Professor of Sociology at Simmons College, Boston, and President-elect of the Massachusetts Sociological Association. Her major sociological interest is in the professions and she is the author of THE PROFESSIONAL WOMAN, an anthology and summary of research concerning women in the professions, and also several articles on professional women. Dr. Theodore has been active in the women's movement as a founding member of Sociologists for Women in Society and chair of its Discrimination Committee; and presently she is a national board member of the Women's Equity Action League and president of the Massachusetts WEAL chapter.

* * * * *

Session III: Questions and Answers

Mary Ott: I think there are a few students in the audience, and I'd like to have some of their reactions and maybe some of their experiences in these areas.

Barbara Wilson: I'm an undergraduate at MIT, and I assume you wanted us to comment on the social attitudes that we've run into. I live in the women's dorm at MIT, but most of the other dorms are coeducational. Officially it is a women's dorm, but unofficially there are anywhere from thirty to fifty permanent or semi-permanent male residents. I've encountered women who feel, like I do, that MIT men are just great and we get along just fine. We approach the guys with the attitude that they probably didn't have much social experience in high school because they were among the brains just like we didn't. Then there are the women who say "MIT guys are not worth two hoots. I don't like them, they're grinds." (The attitudes run through) everything in between. As evidenced by the number of permanent guests, some of the students seem to be getting along. The experience that I've had is that if I made any effort at all to develop any kind of social relationship with a student, I had more than enough friends to keep me busy. What I've run into is that there isn't that much problem at this level. At this point I'm dating one guy steadily, but he has accepted my interests in a career. He knows that I want both a family and a career, and he's perfectly willing to go along. He wouldn't want to deprive his wife of the opportunity to pursue her interests. That's not necessarily the way the majority of the male students at MIT feel. There's the whole spectrum represented. I myself have not experienced any frustration at all, except maybe the first term freshman year, when women get a big rush. Basically, I had to take the phone off the hook every once in awhile and so did a lot of other women I knew, at least for a few weeks until people calmed down to the idea that these women are just like other students and they have things to do.

Paula Stone: I was an undergraduate at MIT and received my Masters degree there. I took a year in London to study and am now back at MIT working on my Ph.D. I think my experiences at MIT were a little bit different than the ones just mentioned. I was an undergraduate in the days when the ratio was still 1 to 18. I ended up in engineering mostly as an accident. I never really knew what engineering was. I certainly didn't know what civil engineering was. I went to MIT being interested in architecture and did not find that much support or encouragement in the department that was just being started for undergraduates at the time. It was an impression of students not being supported in general rather than just females, but I found myself in engineering because I happened to meet a professor who took a particular interest in me and was particularly encouraging to me. So in a sense, I feel that my choice to be in engineering was rather haphazard. As an undergraduate, I think my most traumatic days were when I first entered as a freshman. Only in lecture halls did I ever see any women, which was a new experience for me since in high school my friends were predominantly female. So I therefore had many problems adjusting to that situation. I found that, perhaps more so than my professors, my peers weren't taking me seriously. Everyone seemed to be asleep in classes until I would raise my hand. Then they'd wake up and look around and notice that I talked as well, which was rather disconcerting, especially since after I talked conversations usually went back to where they were before I

offered any suggestions. It was also difficult because I really couldn't skip classes since someone would always ask me the next day why I wasn't there, whereas a male could very easily pick and choose and go and come as he pleased, and no one particularly took notice. I think, in general, the faculty has been quite supportive of me, and I think that's really what kept me going as long as I have been. There've been a few of the older faculty members who have taken a somewhat cutesie attitude. I think these are isolated cases. I've gotten this more at the several interviews that I've had. They're still wondering why I'm doing this and what it is that's the matter with me. I think that, as I said before, it's come more from my peers. In fact, I've had several discussions just this year with my graduate student colleagues who wondered "Well what is it that's the matter with you?" not in so few words, but "What is it about you that is motivating you to try to incorporate a personal life with a professional life?" To them, one has to make personal sacrifices in order to promote one's career and the idea of somehow meshing these two together is alien to them. It's not that they may not want that as well. I think many of them do, and perhaps this whole awareness that women are bringing to the profession is in fact making them think more about their own lifestyles as well. I think one interesting aspect of being a female graduate student is that many of us come with our own support, which has put us in the position where we do not have to join research projects and are left very much on our own. I think this certainly is an advantage in many respects, but it also has not given us a team type of experience. Certainly as an undergraduate, being outnumbered one to eighteen, I was also very much a loner. I always did my problem sets alone. If I ever needed help I would go to TA's. I didn't have that kind of rapport with my male counterparts. I always felt very conspicuous and very awkward and I suspect that the males who might have offered to help me might have felt just as awkward and conspicuous.

Bob Gardner: I'd like to add just a couple of data points, primarily directed toward your comments, Helen. If you look at the Cornell survey, it turns out that there's some very peculiar things. The males indicate that an important thing to them is to be remembered as the most popular student. They indicate a very strong need to join a fraternity. They also demonstrate that in their high school dating patterns, they tended to date either one individual or nobody at all. If you look at the women in contrast, they have played the field. They don't indicate that they want to be thought of as the most popular, and they don't want to join sororities. So it would appear that, on the face of it at least, the women are much more socially adept when they arrive than the males are. And I would theorize that the problem that comes up is, as the girls expressed it here in our groups, "Where are all the boys?" I'm wondering what you think of that theory. I would add as a correlary that here the way it's resolved seems to be that the females tend to find a male who is one or two notches above them in terms of age and who has social maturity. The other question is, has anybody attempted to get around this by placing males and females together at the freshman level, presenting this kind of data, and having them talk back and forth to somewhat equalize these expectations and maybe give them a chance to break the ice?

Helen O'Bannon: I don't know if anybody's done that. I think the point about joining fraternities versus women at Cornell not choosing to join

sororities opens another whole interesting concept concerning from whom you pick your friends. I think initially, as freshmen, we find that the students make friends with the people in their classes. This is the most easy social group because of the difficulty of work and the requirements of time and also because the most frequent contact happens to be among people with whom they go to class. So my analysis of classroom behavior really dwells on the freshman level. Women engineering students (beyond this level) have told me that it's fine to be a civil engineer or it's fine to be a chemical engineer, but that they won't date anyone who is of the same class. They're colleagues, they're peers, they're sort of competitors, but they are not social partners for even a limited period of time. I think this is quite interesting because this is a perception that grows on the women after they have been there a year or two. They've reached a sense of their discipline, a sense of themselves, and a sense of what arenas are important. The classroom for a freshman is a very important arena. Later on, I think there is a maturation period and this is one of the processes that takes place. I don't know whether any one's exposed men and women to these differences.

Mildred Dresselhaus: I don't have any hard data, but I think that fact that women students don't want to date male students in the same classes is a kind of a self-defense and I think it's a very healthy thing, because if women understand intuitively that they should not mix the social with the professional, they really protect themselves.

Lilli Hornig: I want to make a brief comment directed to Paula Stone. You mentioned that women often come with their own support and therefore are not forced to become members of a research team. I would suggest to you that that's a very dangerous tendency. We don't yet have very hard data on this, but we have certain indications that that's precisely what went wrong for women in science in the past. I did want to point out that at least in a fairly large number of dossiers that what has happened to women science graduates in the past is that they either became involved in the problem that the professor had on the backburner for awhile and wasn't terribly interested in getting done, or, alternatively, with a highly speculative problem which he didn't dare give to somebody whose livelihood might be risked by not coming up with a thesis. So I would suggest that it's extremely important, especially for women, to work as a member of research groups from a very early stage. I think if you're truly independent enough to be able to work all by yourself, that's a great thing. But in general you'll find that in your first jobs, unless you're lucky enough to land a place like MIT which has very large groups in a large number of fields, you're likely to be working in an isolated situation anyway and that you're it for that particular sub-discipline. So it's really very important to have had the team experience before you get to that situation of being the only person there.

Shirley Holmgreen: I'd like to add that in industry very little of what you do is going to be on your own. Most of what you do is going to be team effort and if you have not learned how to work as part of a team during your academic days, you may have some difficulty in adjusting to that later too.

Helen O'Bannon: I think this is one of the issues that will be discussed in the session on working in the laboratory, because we'll be talking about engineering projects and team effort, the role the woman has played and should be playing, and how we want to go about equipping her to do it.

Ann Stenbeck: I'd like to speak to what Lilli was just talking about. It's a problem that I have seen because I've been directly involved in looking at it from two sides. There is a great competition for qualified women to enter graduate programs in engineering. Everyone wants graduate women. Therefore, I think they're too often given free rides just to get them to come to the school. That can create incredibile problems if in-house candidates, who happen to be primarily the white males, feel rather justifiably upset that they have been at this school for years and in going onto get their doctorate they have to fight to even get a tuition grant. However a woman who comes in from somewhere else, because she is a woman, is given $3600 a year free tuition. I think that that can be a distinct problem.

I'd also like to speak as a recent graduate. I graduated last year in electrical engineering, and I found a couple of things on which I can look back with amusement but they weren't very funny at the time. One was a definite inhibition both on the side of the majority and the minority in the classroom. When I was an undergraduate, I was the only woman in the electrical engineering department at my level and that meant that I never had another woman in the class with me. There was inhibition on my part in the beginning, before I realized that it would just be an intolerable situation if I allowed it to continue. I finally came to the realization that if I didn't understand some point in the class, that probably at least half of the guys didn't understand it either. They were inhibited about asking because I didn't ask so I had obviously understood it and I was inhibited because they hadn't asked and they obviously understood it. I decided that I was probably going to come off sounding pretty dumb sometimes and ask some pretty dumb questions, but that I was there for an education and that was what I was going to get. And once I started opening up and asking, I'd see these heads nodding around me. So I finally became comfortable in the fact that if I didn't understand it, they probably didn't either. The social thing in the classroom was sort of the same way. There was great peer pressure on the male students not to go up and speak to the woman in the class because in front of thirty three other guys it would look like you were putting the moves on the woman in the class and who wants to be that blatant about it. There's only one way you can combat it, I've found, in the initial stages, and that is to wait until the classroom is half full and walk in and sit down next to someone, because if you just sit there you'll have two empty seats, one on either side of you. Another problem that I found that is amusing now was with lab partners. If these lab partners had steady girlfriends or were married, I'd experience the problem that Sheila spoke of, but even on this much lower level. I'd call up to talk about the lab and pretty soon the wives were saying "Who is this person calling you?" I called up one in particular and (his wife) said, "I don't want you calling my husband anymore. I don't care if you're his lab partner. It sounds like a lousy excuse to me. I don't want you calling him." Girlfriends were also very defensive about this. I thought the insecurity that they had and the threat that I posed was interesting.

Athena Theodore: I'd just like to suggest to you that what you're talking about is how the student copes. I would like to see you collect these things, circulate them around and let the students read them. There's a strategy that students themselves can really put to good advantage because there's a lot of advice here as to "How I did it. The next situation may be yours."

Helen O'Bannon: We're collecting information on recruiter gaffes made by corporate recruiters who come around with all of their Affirmative Action skills. We are now collecting a similar kind of coping mechanism. So I hope we're going to publish.

Lilli Hornig: Let me just respond to the first part of the question. The national figures do not bear out any notable preference in either fellowships or job offers to women; in fact, in the fellowship case I think it's almost impossible to demonstrate a bias. In engineering in particular, I think there might be a slight differential in starting salaries in favor of women for the first time. It's not true in any other field including any of the sciences that are short of women.

Ann Stenbeck: I was just making first-hand observations about Michigan.

Lilli Hornig: Yes, I'm sure there are isolated cases. Well, they may not be isolated, but in total they are balanced by about an equal number in the other direction.

Xanthippi Markenscoff: I'm from Virginia Polytechnic Institute. I think because I did all my undergraduate study in Greece where things are different than what I've met here, I would like to point out some facts that I really don't know how to explain. In Greece about twenty percent of engineering students are female, and the admissions system is free. Anybody who passes the entrance examination, independent of sex, gets in. And although Greece is a Mediterranean country and the males are well known to be chauvinistic about women, still I have found much less prejudice against me there that I could not be a good engineer or do well in my profession. Perhaps this is because there are more women students there, so that if they have seen a woman engineer, this solves the problem. I also should point out that high schools in Greece are segregated. So it is in the engineering school that these boys met women for the first time. I give credit to most of them for accepting women. But things were different for me when I came here. I went to Princeton, which just started being coeducational and there were only six female graduate students in engineering in all departments, none of them American. One was an Arab woman, which was a little bit surprising, and three French. All the students there at the beginning were unfriendly to me, but by the end of my first year we started to have much better communication. These students had never met a woman in their undergraduate studies, so I understand that. But I think that there are men who would be well inclined and that if they met more women engineers and if women prove themselves, they will be accepted. I have seen that also happening in Greece. I may be too optimistic about that.

Christine Smith: I wanted to discuss something that hasn't been brought up yet about the social needs of women in engineering. The women who are interested in going into a cooperative education program, which many women at Purdue are interested in doing, do feel that they will miss something and they will lose connections. I think for those reasons those women who do go on the cooperative programs are either very active in the Society of Women Engineers chapter or they join a sorority. I think that we who work with women can speak of these things as alternatives--they don't have to lose all connections if they join a sorority at Purdue. They can live in the house, which relieves their worries about being stuck somewhere in a dorm with people they don't know when they come back in January, and so forth.

Bob Gardner: Are you saying that women are less prone to join cooperative programs because of those kinds of things?

Christine Smith: It's an apprehension that they have, and a solution that they seem to have found is to join a sorority.

Helen O'Bannon: This is independent of their concern about their position in the corporation where they might go and of fears of not succeeding or not managing or being discriminated against?

Christine Smith: Right.

Xanthippi Markenscoff: At Princeton, we wanted to make a pamphlet on women in engineering to send to high school senior girls. But the women engineering undergraduates protested that they didn't want any kind of special treatment, so we didn't do that. It was hard for us to try to explain that it would help women in the long run. They said that when guys see that pamphlet, the idea that women may be helped and get grades because of their sex may harm them personally.

Helen O'Bannon: I think we're seeing two waves of women in engineering as undergraduates that are rubbing up against each other and resulting in really divergent patterns and insecurities, and I think you may find them in the same class. On the one hand is the woman who is highly motivated by being unique, who likes the competition, who likes to be alone, who later on, when she moves into a corporate existence or into an academic environment, has what many people call the "queen-bee syndrome." (She implies through her attitude that) "I made it on my own, sweetie and you'll make it on your own and I'm going to be tough on you just like the world was tough on me." As Milly was saying today, none of us made anything on our own. We all had help from innumerable people and none of us got where we are and none of us will get where we're going without help. But there is that element of liking to be exclusive and somewhat unique and having people say, "Oh yes, I remember you. You're the only woman in Engineering Analysis II".

There is that group of women absolutely rubbing up against the women who are coming in with a much more cosmopolitan air, a much more open mind to alternative career paths. Engineering may be one way on the road to business, management, medicine, law, etcetera. I think these women are more self-confident. They're talking more of career and marriage and of working them out as best they can. They probably will really do as well as they can provided their mates are accepting and flexible also. But we can't just generalize about the undergraduate woman engineer today. I think numbers will help, certainly, but we're really dealing with several different kinds of populations, just as I feel we are dealing with several different populations of men: the very traditional kind of male engineer, as well as the one who is much more receptive to women.

* * * *

SESSION IV: Women in the Lab--I'll Take the Data

Chairperson's Remarks

Martha Sloan: Today we're going to explore some of the problems in laboratory education. We have speakers who have had experience with programs dedicated to solving some of the problems. One of the things we hope you will help us figure out is whether in fact there really are problems for women in the laboratory that are different from the problems that men have. One interesting thing that has already occurred in some of the various colleges is that you get a different idea of what problems women have in the laboratory if you watch them in the lab than you do if you ask them whether they feel they're having problems. For example, the title of this session "Women in the Lab--I'll Take the Data" refers to the sort of stereotyped image of the woman student in the laboratory who, either through choice or through the greater initiative on the part of her male lab co-workers, ends up not handling the equipment at all, but just sitting there writing down the data. Those of us who have been in labs or taught labs have noticed that this is definitely a pattern. And yet, if you ask these same women, as some of my co-panelists have done, whether they feel that they have any greater problems in the lab than do the men, they say "No, we feel equipped to do the lab. We think we're doing a good job" and so forth. Also, if you look at their lab grades, by and large they tend to do as well on the labs as do the guys. Part of the reason for this may be that labs are still very often graded on lab reports, and this allows women, who may have greater verbal skills than the guys, to make up in report writing what they may not have been quite as good at in the sheer technical manipulation.

So one of the things we would like to look at today, both in our discussions here and in the working sessions, is whether in fact women do have special problems in the lab, and, if so, what is the reason for this? Is it that women, when they were growing up as little girls, didn't have the opportunity to use tools and so forth? Or is it more a cultural thing, that they have just been acclimated not to be aggressive, as manipulative, as investigative, as the guys. Second, if there are problems, are these problems that concern only women or do we find that there is a large group of male students who are coming through who also have not had the mechanical type experience? It's perhaps less common now for guys to buy old cars and to tune them up and so forth than it might have been a generation ago. So perhaps there is a whole group of male students that might have similar problems.

Alternatively, we'll find another main thing to consider is whether women should be isolated for a period of time while they're given some training in lab skills before they're put back with the guys.

Then we can consider the possibility that the problems that we may see in women students today, once we've agreed what they are, may not continue in the future. Can we expect that in another ten or fifteen years most of the girls coming through the lower grades will pick up whatever they need, whether it is some mechanical skills or perhaps assertiveness? For example, we know that just in the last year or so, young girls have been given opportunities that they've never had before, such as being allowed to play on Little League baseball teams. It's

really a whole new ballgame if you're talking about a young girl who has been allowed to develop herself in a way that used to be restricted entirely to boys. Perhaps this is something that will affect their whole idea of what they can and cannot do. Along with that, it looks like the breakthrough toward getting women in to the service academies is finally going to go through. This again is a way of telling women that they can do things that men can. So it may be that we would want to consider the possibility that in the very near future whatever the problems are that women have in labs right now may just vanish because of the changes in our culture. We might not want to spend too much time investigating a variety of programs which we could implement in the engineering schools now, if we might think that within five or ten years there might be no need for them.

Finally, we'll get down to some sort of nitty-gritty points. The people on the panel have all had experience with very special programs designed to increase the lab skills of women in some cases, or of women and men in other cases. They're going to talk about their experiences and what they've learned. And perhaps they'll give you some ideas of what you might want to do at your school.

Martha E. Sloan

Martha Sloan received the BSEE (with great distinction), MSEE, and Ph.D. from Stanford University, Stanford, California. Her background includes research at Lockheed Missiles and Space Company, Palo Alto, California and teaching at the Frankfurt International School, Oberursel, Germany. She joined the Electrical Engineering Department faculty of Michigan Tech in 1969 and is currently Assistant Professor. She has been active in promoting the interests of women in engineering; she has published six papers, guest edited the February 1975 special issue of the IEEE Transactions on Education, and has worked on an NSF-supported project to interest eighth grade girls in engineering. She was recently awarded the Dow Outstanding Young Faculty award by ASEE.

"Basic Laboratory Skills Course at Cornell"

Tom Hall
Carol Hall

Tom Hall: Last spring term an experimental course called Basic Laboratory Skills was given to a select group of sixteen undergraduate women engineering students here at Cornell. The course was initiated in response to a suggestion of the Society of Women Engineers, and its purpose was to improve the students' mechanical and laboratory skills. There were five instructors from Cornell's Engineering school: Malcolm Burton, Mary Ott, Bob Gardner, my wife Carol, and myself.

I am going to talk first about the motivation for the course and the general approach taken. Carol will then talk about how the course actually went. Each of the five instructors (and probably all sixteen of the students) had different ideas concerning the purpose of the course. Rather than try to speak for everyone, I will describe the course from my own point of view. To do this I want to give you a little of my personal history as a background for my ideas in the area of mechanical ability.

When I was a boy we lived with my grandfather whose hobbies were carpentry and painting watercolors. My aunts had a tool and die shop on the same street as our house. My grandfather's best friend had a side-line business of fixing up old cars and selling them. Now, in such an environment there are two things you can do: Avoid the whole thing and read books, like my brother Pete did, or become "mechanically inclined".

When I was ten I had my own shop in a wing of the garage, when I was twelve I learned to run a lathe, and I had my own car to fix up when I was thirteen. Although I learned further skills as I grew older, I don't think later events had that much to do with my having gained so called mechanical aptitude. For example, in junior high school I took only the required shop courses and I took no shop courses while an undergraduate here at Cornell.

My own background therefore leads me to believe that mechanical ability is not innate or hereditary or, more specifically for this conference, sexually determined. I believe that mechanical ability is learned, and for most people it is absorbed gradually while growing up by first doing simple things and later working your way up to more complicated skills.

From my point of view, the problem that we faced in setting up this course was how to give these young women who didn't have this type of background some mechanical ability within the framework of a short course that met only once a week. We realized that we couldn't make expert technicians out of these students within one term, but we hoped that we might be able to get them started on their way to becoming more mechanical, and we also wanted to put them at a slight advantage with respect to their male peers in the laboratory.

The course was arranged on the basis of projects. The first projects were relatively simple and illustrated basic skills, but as the term progressed the projects got more difficult. The first project was to construct a 110V lamp circuit on a plywood board using ordinary household wiring components. The skills to be learned were driving wood screws to mount the components on the board, soldering and tinning wire, and hooking up simple electrical circuits. The second project was a table lamp which required the use of a hand saw and a portable electric drill. The first and second projects took only one night apiece.

The third project, which was the construction of a solid state lamp dimmer, took considerably longer. The first night or two were spent laying out the sheet metal for the box, cutting it with a sheet metal shear, and bending it in a machine called a brake. Subsequent nights were spend drilling holes in the box, mounting the electrical components, and wiring the circuit.

The final project was the machining of an aluminum candlestick using metal-working machine tools. The students were to design the shape themselves and to work out a suitable method for fastening the shaft to the base. Most of the work was to be done on the metal-cutting lathe with some optional work done on the drill press or milling machine.

Also included was a lesson on welding and brazing and a session each on the use of the multimeter and the oscilliscope. We had originally

planned to include a project on auto tune-up, but we didn't have enough time for it.

I want to tell you a little about how a typical class was run: The class met on Wednesday evenings for two hours in an electrical engineering laboratory. Earlier in the week the instructors had met for a rehearsal at which time the least experienced of the instructors would construct the project. Then on the Wednesday evening one of the instructors would show the students a completed version of the project to be built and would demonstrate some of the new techniques that were involved in its construction.

The students were expected to have read the relevant chapters of our textbook, written by me, which covers the tools and techniques that would be needed for the construction of the project. The instructions on the project were quite explicit so that each student knew exactly how to accomplish the task. After the demonstration and discussion by the instructor, the students went to work on their projects. The five instructors circulated through the group and were available to answer questions and help out generally. The students worked on their projects individually; that is, no students worked in pairs.

Carol will now discuss how the course went, including both the instructors' and the students' reactions to the course.

Carol Hall: I'm going to tell you about how the instructors felt about the course--what we would do again and what we would change. I'll also try to give you my impressions of the effect that the course had on the students and I'll give you some of the reactions that the students reported concerning the course.

The consensus of opinion among the instructors was that certain of our procedures in this course turned out to be good ideas and others were not such good ideas. For example: The rehearsal of the instructors, during which the project was built, was thought to be a good idea because it was reassuring to know that the project was indeed do-able and the instructors got a chance to discuss the best way to teach things. The instructors also felt that it was a good idea to have the students work individually rather than in pairs. In this way, we eliminated the problem that can be associated with the pairing of students in traditional laboratory courses so that each student was able to work at her own pace and gain as much hands-on experience as possible.

We also felt that it was a good idea to teach the lessons with somewhat of a cookbook approach as Tom described earlier. This approach had the advantage that each student knew exactly what was expected of her and could simply follow instructions and make the standard design project. What surprised us was that the students were very creative within the framework that we gave them. For example--when the students made table lamps we expected to see 16 more or less standard shop-course-I-type looking lamps with square bases and square shafts (Indeed that was what we made during rehearsal.) Instead--there were lamps with round bases and square shafts and lamps with square bases and hexagonal shafts, lamps with fancy carvings and so forth.

Certain of our procedures did not turn out to be good ideas--for example, we and the students felt that two hours per week was not enough time to learn what we wanted to learn and it was difficult for some of the less experienced students to finish their projects. Also, even though we purchased quite a bit of equipment, there was often a wait for the use of certain tools. This was because all of the students had to use the same tool to make their individual projects. Possible remedies to this would be to have the students work in pairs (which we didn't want) or to stagger the various projects which might lead to a loss in continuity of the lessons and to CHAOS in general.

I'd like to tell you some of my impressions of the course and of how it affected the women that took it. To do this I'll try to give you a mental picture of our first class and one of our last classes.

At the first class the project was to mount a lamp circuit on a board. This involved mounting the electrical hardware on the board with wood screws; cutting, stripping, and tinning the wires; and hooking the wires up. Everyone was slightly uneasy as the class spread out to tackle their projects. The instructors were worried that the project would be too easy--that the students would think that it was too mickey mouse and be insulted, and the students weren't really sure what we wanted of them. As the students began to work we became amazed at how difficult the students found this simple project. Most had difficulty using the screwdriver and all had difficulty in getting their hands to work efficiently for them. At this point the instructors knew that the level of the course was right and we went around the room making suggestions as to how to get the best leverage, what size screwdriver to use and so forth. What impressed me about this group was the intelligence, determination and good humor with which they approached these tasks. One of the students who was having trouble getting the screw into the board straight got a whole bunch of screws and practiced putting them into the board until she had the feel for it. Incidentally it's not that easy to put a screw into a board straight. At the end of this class each student had to test whether she had indeed put together a working lamp circuit. The test, of course, was to plug in the lamp, turn on the switch and see if it worked. You could see that the students were a little apprehensive and embarrassed about doing this, but when they plugged it in and it lit up (which it always did) they were quite pleased with themselves and so were we. At the end of the first class, the students walked out smiling and I felt at that point the course was going to be a success.

Let me now describe to you one of our last classes which was in marked contrast to our first class. Our last project was to make an aluminum candlestick on a lathe. Up until this time the class had been held in our own isolated lab area but for this project we had to use the regular student machine shop. We weren't sure whether the sight of all this machinery and the presence of male students acting and talking like they knew what they were doing would inhibit our students. To our surprise the attitude that came across from our students was one of confidence--they acted and felt like they belonged there. They were eager to learn to use the lathe and many of them asked to be shown how to use the other machinery. Tom had the experience that as he was fixing a piece of the equipment for one of the students, she reminded him that if he would just show her how to fix it she could fix it herself. In general the students were much less self-conscious about asking questions than they had been originally and they struck me as being much more

independent and mature. I'd also like to say that the candlestick project was one of our best-liked projects perhaps because there was a great deal of room for individual creativity.

Our very last class was a pizza party at which we asked the students their reactions to the course and what they thought we should do in the future. They expressed the opinion that the course was definitely worth while and should be taught again. They all thought it should be open to men but when asked whether men and women should be mixed in the same section the answer was a unanimous NO.

To sum up I'd like to say that we learned a lot of basic mechanical skills in this course but that there is a great deal more that was not covered. While I don't think that any of the students is well trained in the use of tools and laboratory equipment, I think that from now on they won't be afraid to tackle new problems of this sort and that they will have justified confidence in their ability to learn new skills. I therefore think that the course achieved its principle goals and was a success.

Thomas M. Hall

Thomas Hall is an experimental solid-state physicist. He was an Engineering Physics major at Cornell and did his graduate work jointly at the State University of New York at Stony Brook and Brookhaven National Laboratory. He is presently a postdoctoral research associate in the Department of Materials Science and Engineering at Cornell working on new experimental techniques for investigating materials science problems. He is an inveterate tinkerer and builder and aside from constructing experimental apparatus does work around the house and repairs his own cars. His background for teaching the Basic Laboratory Skills course includes a respect for tools and a desire to teach others how to use them properly. He is a member of the American Physical Society, the National Organization of Women, and the National Model Railroad Association.

Carol K. Hall

Carol Hall is a theoretical solid-state physicist specializing in statistical and chemical physics. She was a physics major at Cornell and received her Ph.D. from the State University of New York at Stony Brook. She is presently a postdoctoral research associate in the Chemistry Department at Cornell working on developing theories of fluids, magnets, and alloy mixtures. She is an experienced teacher of undergraduate engineering and science majors with a reputation for being concerned about the students' progress. Her background for teaching the Basic Laboratory Skills course includes a desire to help others learn about tools and a sensitivity to the problems of professional women. She is a member of the American Physical Society and the National Organization of Women.

"New Avenues"

Dennis Shay

The New Avenues Program was started in 1971 with an NSF Grant at the University of Oklahoma. Its purpose was to encourage women to enter careers in Physics or other Physical Sciences and also to see if the women who entered the program were different from "other women." A report on the first two years of the Program has been published by Pollack & Little in the Physics Teacher, II, 391 (1973). A renewal grant for four years involving joint OU-NSF support was made in 1974. Project Director is Betty Pollack.

The program takes the form of a Freshman level one year general Physics course with a lecture (3 hrs.) and a lab (2 hrs.). Also involved is a clinical psychologist, Lee Little, who aids in counseling and acts as a medium to get feedback from the students concerning what we are doing with them.

The girls who enter the program are mostly freshmen. For the first three years all had already or were given scholarships. They were chosen on the basis of high school grades and ACT test scores; and the better students were chosen. The girls were then placed in a beginning calculus course and a standard text on General Physics for engineers was used. The program, academically, is not a remedial course, but it was for women only the first three years of the program. The first semester sophomore year the girls took a modern physics course taught by the project director because she felt students needed a modern Physics course at this level. This course is now being taught to all Physics majors. The second semester sophomore year and onward they are thrown into the machine with everyone else.

Contact with the girls is maintained through advising and through student assistantships. The advanced students act as tutors for the freshmen and as aides in the course.

The lab was run by various people over the years, by Dr. Ruth Howes and myself, the first year, and then by Dr. Bill Atkinson and me the second. Bill took over the third year and then left OU. Then Stephen Whitmore took over this last year. The detailed material changed over the years, but the overall format was about the same. First, a group of structured experiments are done and written up. Students work in lab groups of two or three which are changed each week. Then there is a six weeks machine shop segment followed by a segment involving some self-paced electrical experiments and/or special projects. These labs seem effective and the students like them. It also seems that what they do is not important as long as they do something non-trivial, and the apparatus works. Some of the projects were exhibited on Science Day to high school students.

This last year, 1974-75, it was decided to integrate this program with the regular Physics program. One reason was that the enrollment in the regular freshman Physics course had been running about ten students for the last three years and was pretty marginal. New Avenues enrollment ranged from twenty-four to twenty-one to eleven, so it seemed a good idea to combine them. We and the NSF, apparently, were interested in how

integrating the program might affect it. So, in 1974, sixteen women and twenty-four men enrolled in the course. For the first time the project director did not teach the course due to administrative obligations. I taught the lecture with sixteen advanced women as student aides, and Stephen Whitmore taught the lab with the help of two graduate TA's, one of whom has been in the first year's program. We had two clinical psychologists, Lee and Ernie Little, who worked with the students in various group combinations. We settled down to a single group because the men were extremely unresponsive. Since the bi-weekly meetings with the psychologists were voluntary, a regular group of about fifteen (somewhat less than half) attended.

For the first semester a group of set experiments were performed and lab groups were changed each week. No significant differences in the work done and grades earned were found. TA's noted no difference in work habits--everyone shared the work. During the second semester the machine shop segment was delayed because the department machinist had other obligations. So after a false start the students were given a choice of doing special projects or a sequence of self-paced experiments. Students were also allowed to choose their own lab group. The women grouped together and so did the men. No women chose to do special projects, and because of the self-paced nature of the lab, most students did not work very hard. Self-pacing can be a mistake without setting some goals. As a whole, this group had trouble with the self-pacing segments of the course. The men approached the machine shop with enthusiasm, the women with mixed feelings. Grades for the second semester lab show no difference in the performance of the students, equal weights being given to projects and the electrical experiment sequence. The statistics for the program are the following:

Major Subject for Women Who

Completed Either 1205 or 1215 or both.

MAJOR	71-72	72-73	73-74	74-75	Total
Physics, Astrophysics Engineering Physics	8 (34%)	4 (19%)	2 (18%)	3 (20%)	17 (24%)
Engineering Mathematics, Geophysics	2 (8%)	5 (24%)	0	3 (20%)	10 (14%)
Science Education	2 (8%)	0	1 (9%)	0	3 (4%)
Subtotal	12 (50%)	9 (43%)	3 (27%)	6 (40%)	30 (42%)
Biological Science (including clinical)	5 (21%)	5 (24%)	5 (45%)	3 (20%)	18 (25%)
Other (e.g., humanities, business)	2 (8%)	5 (24%)	2 (18%)	0	9 (13%)

University College	5(21%)	2 (9%)	1 (9%)	1 (7%)	9 (13%)
Unknown (not physics)	0	0	0	5 (33%)	5 (7%)
	24	21	11	15	71

Major Subject for Women and Men Who
Completed Either 1205 or 1215 or both.
(1974-1975)

MAJOR	GIRLS	BOYS	Total
Physics, Astrophysics, Engineering Physics	3 (20%)	12 (60%)	15 (43%)
Engineering, Math, Geophysics, Chemistry	3 (20%)	4 (20%)	7 (20%)
Science Education	0	0	0
Subtotal	6 (40%)	16 (80%)	22 (63%)
Biological Science	3 (20%)	0	3 (9%)
Other	0	0	0
Undecided	1 (7%)	0	1 (3%)
Unknown	5 (33%)	4 (20%)	9 (25%)
	15	20	35

Actually there is nothing on paper to indicate any detrimental effect of mixing the men and women. Both men faculty members and the male psychologist feel it was a mistake, the female psychologist seems not to believe this. However there is a very great difference in the spirit of the program and it seems to be correlated with intensity of psychological counselling, total number of girls, and sexual segregation. The intensity of student-faculty relationships was also a factor, and this decreased as the program "matured."

For the first year the women attended bi-weekly group meetings and individual meetings with the psychologist. Some social events, parties,

were given by the project director and a group feeling among the women along with a nice student-faculty relationship resulted. Of the twenty-five girls in the first group, nineteen chose to stay the second year although this number has since decreased to twelve. The second year was a similar experience, a good spirit, and fine student-student, student-faculty, and even faculty-faculty relationships. The intensity of psychological counselling decreased to bi-weekly meetings with, I believe, fewer individual sessions.

Also women physicists were invited to speak to the women. The talks consisted of a Physics lecture on the freshman level, then an open question session where the speakers were grilled on all sorts of personal matters. I cannot conceive of such discussions occuring in a mixed man-woman student group. I was there, but I didn't count. Such talks as these, I think, are incredibly valuable, but maybe not. Such discussions could be helpful to men also, who often really don't know what they will be doing when they get out. Some speakers who came to the program were people we, perhaps, could not have gotten for our colloquium.

The third year I know of only from hearsay since I was not with the program that year. There was a lapse in recruiting and the class was small and somewhat spiritless, I believe. Two girls did remain in physics, one of whom has impressed at least one rather conservative faculty member in later courses.

The fourth year, this last year, the class was large, forty students originally, sixteen women and twenty-four men. There was some element of enthusiasm in the beginning, but somehow, at the end the course felt just like a service course. These are my feelings only; I can't really back them up. It was due, I believe, to the size of the class, the mixing of men and women which prevented any sizable group from forming, and the decrease in intensity of psychological counselling. The results obtained in the first years may, in fact, have been obtained by efforts above and beyond the call of duty in a university.

Some qualitative results of the integration of New Avenues:

Overall, the grades were distributed so that the women's were contained within the men's distribution. Men higher, women coming in about low A,B level.

Lab, the women again were distributed so that the best and worst were men.
The best: The men who picked projects and did them well.
The worst: The men who picked projects and did nothing.
The women: At least they were realistic and did what they said they would.

Self-pacing: There were self-paced unit quizzes associated with the lecture segment. Students did not self-pace well at all. Women were slightly worse than men; the schedule for quizzes was set by the lecturers and only near the end of the first semester did one woman get on schedule. Three men were on schedule, one ahead, the rest all behind. Second semester-women did relatively better, some worked a little harder, some men worked less.

No group of women formed that I could see. There were two's and three's. The class started off well, but the spirit went out somewhere.

Question: Do women need to be segregated for a time?

Dennis Shay

Dennis Shay was born in 1938. He and his wife have one five-year-old daughter and two sons, ages ten and eight. He received his B.S. in 1959 and his M.S. in Physics in 1963 from the Illinois Institute of Technology, Chicago. In 1966 he obtained his Ph.D. in Physics from Iowa State University, Ames. Since 1968 he's been Assistant Professor of Physics at the University of Oklahoma, Norman, specializing in theoretical physics, relativistic quantum mechanics, and field theory. Dr. Shay has been associated with the New Avenues Program at OU since its beginning in 1970.

"An Experimental Program to Reduce Attrition Among Women Science Students"

Lynne Harrington Brown

I may be able to provide a partial answer to the (segregation) question. I thought I might start with a few brief comments about Purdue. Most of the participants in this conference seem to be from the east coast, and I know there is one other representative from Purdue here, but I get the impression that there are some misconceptions about the institution which it might be useful to dispel. Purdue is a land-grant institution. It is in the public sector. Currently we have about 27,500 students on our main campus. It is not totally engineering, it is not totally agriculture. We have a very large School of Humanities. We have a number of professional schools: Pharmacy, Veterinary Medicine, Business. We also have the School of Science and the School of Engineering. I am located in the School of Science. I am not in the School of Engineering, and I will be talking mostly about the School of Science. The other thing that I think is important here is that, because we're a land-grant institution, we do not have the highly selected student body that many of you experience who are from small private schools or large private schools. Our students come mostly from Indiana and the surrounding mid-west states. The only admissions requirement for the School of Science is that they must be in the upper 50% of their class in high school rank. So that means that we get a very broad spectrum of students, male and female. We get some very good students, we get some very poor students, a lot of high risk students, and we get this big bunch in the middle. And I ask you to keep this in mind as we're talking. Now I was asked to talk about the faculty-student research projects for sophomore women students in the School of Science at Purdue this past year that we instituted on an experimental basis. I will talk about that, but first I want to describe some of the antecedent events that led up to these projects and the total program of which these projects were just one element.

This program involved only science majors, and by that I mean the biological sciences, including computer science, the physical sciences, the geo-sciences, Chemistry, Physics, and so forth. However, in the last few days, I've gotten the impression that in many ways the program I'm

going to describe would be even more relevant to the participants in this conference than less. The thrust here are the problems beyond recruitment. In the School of Science, we've been beyond recruitment for a fair number of years. In fact, the percentages of men and women science undergraduates in the past year were 59% and 41% respectively. We expect to reach parity within the next two or three years. So, therefore, the solutions that we seek for the difficulties that our women face lie for the most part in the future for the engineering schools, which is not to say that the problems that our women students face are not the same. In many instance they're identical, but because of the large numbers of students that we are dealing with, the solutions must be different. What's possible with sixteen, twenty-five, seventy, or a hundred students may not be possible when you're talking about hundreds of students of varying ability levels. So it is with this in mind that I said that what we have done with our women science students is relevant to this conference. We have been where you are going. And I'm hoping that you can avoid some of our mistakes, and perhaps some of our successes will be useful to you.

In 1971, I was employed by the then Dean of the School of Science to explore the difficulties that undergraduate women in science were facing and then to develop programs to remediate these difficulties. At that time, neither the Dean nor anybody else in the School had any idea what this was going to mean, and frankly, neither did I. It was just a vast unknown area. The only data that we had at the time was from a dissertation that had been done in the early '60's which had indicated that an attrition problem might possibly exist. Putting is mildly, it was something of a shock to discover that the attrition rate for undergraduate women science majors had been fluctuating around 75% for any given entering class for over a decade, in the decade ending in 1972. And this was as compared with a 60% attrition rate for male students. It was high all over, but it was phenomenally high for female students. Further, we have discovered that this differential rate could not be attributed to academic performance variables. In other words, the women that were leaving had as good grades as the women who were staying. It had nothing to do with academic performance. And by attrition, I should make this clear, I do not mean students who have academically failed. By attrition, I refer to students who have transferred to non-science majors for the most part. We considered engineering to be a science-based major. What we were really concerned about was this huge bulk of young women who were going to the more traditional fields of home economics, the humanities, nursing, those kinds of fields. The reasons for this were not clear, why all this was occuring, and they're still not clear, although we've been able to identify some variables, and it's basically the list that we've been talking about here: inadequate counselling, the isolation of the students, lack of role models, you've heard it all. It was the same situation. So, subsequently in the fall of 1973, a two-year combination action and research program was initiated with a very generous grant from the Fund for the Improvement of Post-Secondary Education, to attempt to reduce the attrition rate, and also try to learn some of the underlying reasons why it was occuring. The program was targeted at freshman and sophomore women since it had become apparent that most of the attrition was occuring in the first four semesters. After that, a girl who stayed in any of the science majors through her fourth semester was probably going to graduate in one of

those majors. She probably would not leave. The action part of the program consisted of three elements. Intensive counselling, which was to continue for the entire two years, a special career role models course, an awareness course if you will, which was to be offered to program participants in the second semester of their freshman year, and then throughout the entire sophomore year, the student-faculty research projects. These three elements were embedded into a research design, so that we had one hundred twenty randomly selected entering freshmen women to form the experimental or treatment group. I have copies of a report which describes in detail how all of this was set up, so I won't go into it. If you're interested, I'd be delighted to give you copies. Rather, I want to talk a little bit more about these various elements.

We defined intensive counselling as being three regularly scheduled sessions, a minimum of forty-five minutes each, with the same counsellor. And we had six counsellors for one hundred twenty girls, three of them male and three of them female. We were interested in seeing if there were any sex differences that could be linked to sex of counsellor. At the end of the first year, there didn't seem to be anything there at all. However, I'm not sure about the entire project. It may be a cumulative effect. It's still an open question. The students set up the counselling sessions with the counsellors. There were no restrictions on what they could talk about. They took care of their academic matters, registration and so forth, and then counsellors were encouraged to spend as much time discussing personal matters, problems in the dorm, boyfriends, careers, whatever the student wanted to talk about. What actually happened was that most of the students went way beyond the three 45-minute sessions. They began to develop very close relationships with their counsellors. Many of them were in on a bi-weekly, sometimes daily basis, and this is still going on. So we had very close interaction. We had both the counsellors and students fill out evaluation forms at the end of each session. And we were trying to see how close their perceptions were of the rapport that was going on, and in general, what was happening to the students. It was remarkable. The counsellors and the students agreed almost 100% of the time on how confused the students were. In fact, sometimes the counsellors were even more perceptive than the students. They could predict where there were going to be problems.

The special course was similar to ones that I know some of you have run. We tried to hit on three elements at one time. Now as I said, we have a role models problem in the School of Science. Out of about 230 faculty members, we have between twelve and fifteen women faculty. About a third of those are at the full professorial level and the rest are scattered. They are not distributed across all fields in the sciences. Most of them are in biological sciences. There are a few in Math, one in Physics, one in Chemistry, and none in statistics and none in the geosciences department. So we just don't have role models. In addition, about half of these women are research-oriented people. They do not teach at the undergraduate level; they are rarely seen by undergraduates. So the only female employees that our women students were seeing were the clerical and secretarial staff. They rarely saw a female faculty member. So we wanted to do something about that. We also had picked up from the students a tremendous need for career counselling and career guidance, which I think everyone here has experienced. So we thought we'd try to do something about that too. And we decided to incorporate all of that into this course. It was a three hour course offered on a pass/no pass

basis. The credit could be used to count as lecture credit toward their degree. And we essentially had two courses running in parallel. We brought in faculty members, female faculty members where possible, every week. Over the semester, we covered all the basic science areas plus medicine and also engineering. About every four or five class sessions, we picked up a new area. We started with biology this year and we ended with the geo-sciences. In the first part of the week, we would have a faculty member come in and very broadly talk about the career opportunities in the field and what the field was about. These people were carefully selected. We tried to pick people whom we knew were in sympathy with the goals of the course, and they would just talk about what a synthetic chemist is, how a physicist thinks, what sorts of problems these people are interested in, what kinds of jobs you can get, how many degrees you need. We covered this kind of thing for about two or three sessions in these class periods. Then after we'd been through this introductory period, we would bring in a woman professional, usually from outside Purdue because of our small numbers. For every major, for every science area, we had at least one woman professional who would come in and talk to the class. This was a formal period. That always went all right. But the thing that turned out to be most useful was that when these people came to Purdue, in the evenings and throughout the day we set up informal sessions. In the evening particularly, we'd meet in somebody's home, either mine or one of my co-instructors', and over Cokes, wine, beer, whatever is available, we'd sit for an hour or two hours and the students and speakers talked. And it was in those informal sessions that some of the really tough areas and the concerns of the students came out, i.e. marriage vs. career and so forth. And that part of it has been very successful. In fact, the course has been very successful. It's a women's role models course; it's also a careers course. Then this past year we decided to do something else. We added a third part to it. Each of the students was required to prepare a research paper on a topic relating to women. They could select from about twenty-five topics, covering everything from child-care to the Equal Rights Amendment. In that way, we covered an awful lot of material relevant to the status of women in the sciences which we probably would not have covered in a formal lecture section. And that's the course. Evaluations have always been in some ways humbling. The students inevitably start out being somewhat hostile, ranging from hostile to neutral. Many of them swing 180 degrees. They walk out of the class saying, "I'm going to take on the world." They walk out of the class saying, "I can be a physicist. I know I can make it. I've seen all of these people and they have made it." And, incidentally, I should say that we bring in senior undergraduates who have done interesting things. We bring in graduate students. These are all female. I've had students say, "I listened to so-and-so and she started off as a biology major and then went to physics and she made it, and by God, if she can make it then I can make it!" This has been, as I've said, a very successful event.

Since we were continuously collecting data on both the counselling and the course, we were able to check on how we were doing at the end of the first year with these 120 kids. The results were astounding. For the experimental group, we essentially had cut the attrition rate in half in one year, as compared to all other freshman women in the same class. It was considerably below that of the male students. Again, for those of you who are interested, my report has the details of the statistical analysis and so forth, which you'd be welcome to read. Last year

then, in the fall of 1974, the faculty-student research projects were made available to this same group of kids, the members of the experimental group. Now these projects actually were no different than what most of the concerned faculty have always done. All we did was systematically go about it. Briefly, we solicited faculty willing to work with sophomore students, either on supervising individual research projects or in taking the students directly into their labs and integrating them in with their graduate students and so forth. Then we soliciting students. We asked the students "How many of you would be interested in doing this?" What we wound up with were far more students than we ever were able to place, because this was on an experimental basis. We wound up with forty-two students altogether, twenty-one of them male, twenty-one of them female. We did ask for male students. We decided that we had to find out whether or not women could perform in the presence of men, what was going to happen if we integrated them, since they are not going to be segregated once they leave the university environment or our program. So we had nine groups of students varying in size from two to six members, and these groups were spread through all of the science areas. We had projects representative of all areas. One group was all female, two groups of two members each were all male, one group had three females and one male, and five groups were initially 50/50. Of those five groups, three of them representing the fields of computer science, statistics, and chemistry became, within a matter of the first few weeks, predominantly male. I'll return to this point.

The projects have ranged all over the place. Some of the ones in biology had to do with cancer research. In the geo-sciences, which was one of my favorites, an individual is interested in physical anthropology. He was teaching the students the use of machines to go out and discover things such as Indian burial mounds, so they learned all kinds of machine skills and computer skills, and they also learned how to work at a dig. We had a lot of students who were very interested in that. Since we don't have an archaeology major at Purdue, this was a substitute. They thought this was really neat and so did I.

The evaluations were very interesting. Not surprisingly, the students of the most enthusiastic faculty members reported the most favorable experiences, and they were the most enthusiastic. But all of the students felt the experience to be valuable to them, both the boys and the girls. Now I should say that the amount of time consumed in these things varied somewhat. The students and the faculty negotiated. Most of them involved about ten to fifteen hours a week working in a lab directly with the faculty member or under the supervision of a senior graduate student. As indicated in the abstract, the girls who indicated the most favorable experience and stayed with the program all year were either in the all female group or in one of the groups that retained their 50/50 sex ratio. In all of the other groups, girls reported unfavorable experiences and they were the ones that dropped the projects. No students reported sex discrimination, neither females nor males. We asked them, "Did you see any evidence of it?" In fact, we took the questions directly from the questions we're going to discuss in the working sessions. And there was just no evidence. They said, "Absolutely not. There's no difference." The faculty members and teaching assistants involved said they could not detect any difference in the approach of the male and female to the lab experience. However, in those three

groups with the drop from a 50/50 to a predominantly male composition, the reasons given by the girls were uniform. First, they said they had poor math background, and second, they did not feel that they could perform at a respectable level academically. They had a very bad lack of confidence. Now what makes this interesting is that in reality these girls had essentially the same math as the boys, there were no differences, and they had essentially identical academic records. There was no reality basis for these feelings. It was a perceptual thing. And this forces me to conclude that peer group support, the segregation of the girls and boys in these initial lab experiences, is absolutely critical. If the girls perceive themselves as being less capable, less prepared, they simply quit, even when there is no reality basis for it. And I think that's one of the most important things we discovered about it. We certainly discovered what happened when you put boys and girls together in the same lab and we probably won't do that again. We will keep the girls separate since this is clearly where the best experiences have occurred and that's where the students felt they had gained the greatest benefit. Finally, in terms of the benefits of these things, the students, both male and female, found these projects extremely helpful in their career decision-making, in that it gave them a chance to get involved with a "real" research lab. They found it made their classes more relevant, since many of the things they had learned in the lab or had observed they talked about in the classroom in later courses. They felt it gave them a distinct advantage over their peers who had not had these experiences. They also reported they were more motivated because they said they could see where all of this--the calculus, the physics, the chemistry--fit into a real life project, and for some reason they felt they would study harder because they could see where it was going.

Now, has this whole two year program reduced attrition? Well, the answer's not totally in yet. We've been analyzing the data for over a month and the results just aren't ready. As I said, at the end of one year, "yes." At the end of a year and a half, the answer was "yes." For the girls in this experimental group, the attrition rate was still reduced from that of all other freshman females. Considering preliminary results, the answer is still "yes," but I don't know. I should add one more thing. In 1974, a second sample was drawn and we have replicated the entire program for validation purposes. At the end of the first semester for the second group, the results were identical with our first time around. We saw exactly the same phenomena, the same drop in attrition resulting. Again, the preliminary results for this second group appear to say, "yes" they will replicate our entire project.

In summary, briefly I would like to indicate how all of this answers some of the questions that have been raised here in regard to women in engineering. One of the things I should say is that Christie Smith is the person here from Purdue from the School of Engineering. The Engineering School has run a course similar to ours and in fact has just done many of the same kinds of things, although not quite in a formal research design. I know she'd be delighted to tell you what they have done there.

First question: Should counselling and other support programs be institutionalized? Our answer would be "yes," for women undergraduates, at least in the present. I think this is true whether they're in the

physical, biological, or mathematical sciences, or in engineering. Ad lib counselling or informal arrangements are just not enough to meet their needs. The kinds of problems these kids are dealing with are simply too complex to be dealt with on a purely casual basis. There's got to be some kind of a formal responsibility assumed by the institution.

Are role models of value? Yes, until such a time when women faculty become plentiful enough to provide visible and accessible role models, other measures must be taken. I know some of the suggestions have been made about assigning women students to women faculty. As I said, again for the engineering school right now like Cornell, where you're dealing with seventy people, that may be possible if you have one female faculty member. When you're dealing with classes of two or three hundred, obviously that one female faculty member cannot possibly cope with all of those human beings. So, in the meantime, until such a time as the female faculty reach equitable numbers, other measures must be taken. It is our feeling that although a flashy conference once or twice a year is dandy, it will not really solve the problem. We feel that in some ways our course, while it has problems, comes as close as we can get in that we have an almost daily interaction between our students and faculty. Granted, most are not on campus, but at least they are visible, they are accessible for a short period of time. Not only that, but we find many of our students have kept up long term correspondence with the speakers that we've had. They've been able to get that close to them in a relatively short period of time.

Should one provide research opportunities like those described here at Cornell, like those at Oklahoma, like what we've found? Yes. As a student here from MIT said yesterday, undergraduates can do research, and without doubt it's of great benefit to them, even exposure to simple skill levels. I would say from our experiences that this should be an isolated event; the undergraduate women seem to need that boost, that start. Whether they're facing a test tube or a wiring board, it doesn't seem to make a difference. If it involves anything using their hands, we've got problems. At least it seems so from our experiences.

Finally, is this program we've had transportable and relevant to engineering? I would say so. Very little of what we've done is expensive. The biggest budget item is simply the personnel for the counselling. All the rest of it already exists. It's just a matter of systematically going about it.

Recruitment is not enough, and I would add, not without the support programs. To me, recruitment is a two-way door, and I'm afraid that unless the engineering schools learn from the larger majors which have been through this, we're going to see as many engineering students at the undergraduate level swinging out as well as swinging in.

Lynne H. Browne

Lynne Harrington Brown is located in the School of Science at Purdue University, where she divides her time among academic and personnel counseling, administrative duties and the direction of special projects and a program for women undergraduate science students. Ms. Brown, who has a B.S. and M.S. in Experimental Psychology, comes from

a military family and, consequently, has lived or traveled in 48 of the 50 states. She currently is deeply involved in preparing a book that evolved from her work with women science students for use by secondary counselors and in Women Studies programs. Ms. Brown lives near Purdue with her husband, three children, and two border collies.

Session IV: Questions and Answers

Martha Sloan: You've certainly held out a lot of hope for those of us who come from state universities with fair sized numbers of students in science and engineering and who can't quite see how to nurse each one of them along individually. . . Further, all of our speakers this morning have come basically from Schools of Science, predominantly Physics. . . So it may be that there's a lot that those of us in engineering can learn from people in the sciences who have worked with larger numbers of women for many years. And we can, as Lynne says, try to learn from their mistakes and copy their successes.

Irene Peden: I would like to point out in connection with the use of hands and hand skills that perhaps we should make a distinction. Use of tools and knowing how to use tools is one thing, but knowing how to use your hands for, let's say, precision laboratory measurements is quite a different thing. And I would say from my own personal experience that a person can be very big on one and very very short on the other. I did my dissertation in a precision measurement Stanford microwave laboratory. I am nothing when it comes to the use of tools, nothing, a klutz. I still am, I guess because I've been in the fortunate position of being able to hire to get those kinds of things done, so I never had to learn. But, when it came to doing a precision measurement and understanding the concept of the measurement and being able to do the extremely fine tuning that was necessary, I was the champ of the Stanford laboratory. I was the student that all the other students consulted. So, the disparity is very very great, or could be, and I would just like to point that out as a distinction that perhaps we ought to consider.

Martha Sloan: That's a good comment, and actually, if you look at women's aptitudes in general, women are supposed to be on the average more oriented toward using very fine hand skills that would go along with something like that. As most of you know if you go into almost any solid state factory you find that it's the women who are doing the tiny connections under large microscopic magnification, simply because they do have, on the average, more potential for very fine measurements. I don't know if this means that we should sort of counsel women towards that end of things if that's what they're interested in or not, but it does show that even if they haven't had very gross kinds of experience, say sawing or something, there are lab skills that they can pick up very quickly.

Ann Stenbeck: I had an experience as an undergraduate in a lab that I would like to share with people because I think it's something that wasn't mentioned this morning due to the mainly segregated lab experiences that were presented. In an upper level electronics laboratory, we were put into lab groups and I was in one with just one other young man. He looked at me and said, "You can take the data and that's all you can do. You can't touch this equipment." And I would try to do things and he would take the equipment out of my hands and do it. If I wired components together, he would take it all apart and do it himself. I was astounded. I had never seen this before, and this was an isolated experience, but I was floored. I didn't know what to do. And I kept saying, "Now look, I can do this too" and he said "Forget it, you can't do it. You read the dials." And he wouldn't even trust me to read the dials. I would read off a measurement and he would look and check to make sure that it was right. He wouldn't believe what I had said; he

had to check it and then he would write down his answer. I was lucky in that I went to the professor and said "You're not going to believe this, but this is what is happening in this lab." And he was very responsive to the problem. I was the only woman in the course, there were about fifty (students) and there were four lab sections. He said "Who is this guy? All right I'll assign different groups every week and I'll make sure that you never get in the same lab group with him again, and if you ever have any other problem of a similar nature, please come talk to me about them." I was lucky in that he was responsive and there was a very easy solution, not a solution since the problem would still be there in the future with this young man and any other woman who was in a laboratory with him, but I could at least have some method of getting through the lab and not just be the one who sits and reads the dials. I know another woman at Michigan engineering who did have a similar problem, but hers was very much intensified because her lab partner would not even give her the data. He'd say "Give me your copy and I'll take it home and copy it and give it back to you" because they had a lab setup where one person had to write the data down while the other person was doing all these other things. Well, it would come the night before the lab was due and he would either conveniently not be home or he would have managed to avoid her all week and so she would not have the data to do the lab. She was in a position where the lab instructor was a very close friend of this person who was driving her crazy and the professor was also a very good friend of her lab partner, and she felt there was no recourse, and she had a disastrous lab experience. I wonder if anyone has any comment on that and if anyone has got a survival tactic for dealing with something like that.

Martha Sloan: I would say that if it was her copy of the data in the first place after the first such time she wouldn't give it to him, but other than that, who knows.

David Morris: I'd just like to corroborate that. I'm from the University of Virginia. In my experience with female students in counselling and listening to some of their problems, it appears that they experience more pressure in such cases from their male classmates than perhaps from the faculty and the more subtle, commonly though of forms of discrimination and pressures that can be brought to bear on them. And frankly this is a very vexing problem for us. We've stopped short of introducing the problem to our male freshmen and indoctrinating them in some hopefully constructive fashion. We have not chosen to do this merely because of, perhpas, our short experience with this and because it may be out of proportion. But I will allude to a similar impression, that perhaps it is their very classmates that are creating some rather unfortunate situations for the women.

Mary Ott: I have heard of a case here of a woman student in Physics. She had been doing labs in a course in which there was a teaching assistant. She had a female lab partner, and when they would do the lab and have a problem, they would ask the TA for help. Then he would take over and do some of the work. Then she would complete the lab and write it up. This went on all semester. At the end of the semester the student got a C, and since she's an A student she was very shocked. Her lab reports had been good. But the TA told her, "Well I've done all the experiments for you, so how could you get anything else but a C?" So it's not just students sometimes. Sometimes it is TA's who just aren't very aware.

Michael Fisher: I'd just like to make a comment. First of all, the question of dominance in partners is one obviously that applies equally to men as to women. The problems are there and could obviously be accentuated if they're between the sexes as well because of the stereotypes. But I have a comment that I think might be worth bearing in mind, because it affects this matter of male prejudice, and that's the question of women role models for men also. Part of the reason that women get stereotyped is that the men never see any women professionals. So I think I'd encourage you to have these women who have made it come and maybe address some classes of men also. I remember as an undergraduate being very impressed by Dame Kathleen Lonsdale, the X-ray crystallographer. She gave marvelous talks incorporated with working with that sort of thing, and I think that made an impression on me as a boy.

Tucker McHugh: I'd like to make the same point about mechanical skills. There are women who do have them and who do better in their labs than their lectures, but they're probably a small minority. There are also men who don't have those skills. We have routinely for a number of years given the Bennett Mechanical Comprehension Test, which is what I would call"Kitchen Physics", very applied physics, to all of our engineering students who are coming in for special counselling with problems or who are leaving engineering. We find many of the males scoring very low on that. We have seen over the years, we think, but we don't have any data on it, a lessening of that kind of mechanical comprehension among the men, and we've speculated about this. We feel that perhaps one of the reasons is that New York State has gone, I think uniformly, to using PSSC Physics in high schools, which is, for those of you who are not familiar with it, very abstract. Yet we get students from other states who are still getting the older kind of Physics, the more practical kind of Physics. So I think in terms of understanding basic mechanical principles, again you're going to have to look at individuals and not make assumptions on the basis of sex.

Summary of Working Groups

Group I

Martha Sloan: We concentrated on more general aspects of retention. We thought that perhaps much of the kind of lab experience represented by the simpler projects in the Cornell course could be pushed down into the junior high schools and the high schools. Of course, it's a traditional solution for college professors to suggest that if the previous levels just did their jobs then we would have no problems. But it seems quite possible, with the advent of Title IX, that within a few years we will find women students picking up some of those skills at a lower level. However, if women students generally make the decision to enter a technical education relatively late, perhaps as late as the senior year in high school, it's very unlikely that they will elect industrial arts or technical arts. Thus if these subjects are not part of a compulsory program for all students, it's not very likely that women will pick them up. The other major idea that came up out of our session was that confidence or assertiveness seems really to be a more important factor in laboratory education than simply the technical skills. We agreed that the major benefit of some of the programs that were discussed this morning probably was the increase in confidence. These programs might

bring students' confidence up to a level at which they feel they can tackle any new kind of skill learning activity on a basis equal to anyone else.

Group II

Carol Hall: One of the main things that we talked about was the fact that in many engineering schools, at Cornell and at other places such as the University of North Carolina, there is a deemphasis of laboratory instruction. Many years ago an engineer normally took surveying, metalworking skills, foundry work, and so forth. These were required courses and everybody had to take them, the women as well as the men, although there were very few women. One of the women in our group said that she had to take all these things in school and she really enjoyed it. Today the emphasis in most engineering school seems to be on theory. In fact a professor from the Agricultural Engineering School here at Cornell said that agricultural engineering, which sounds like it should be a very practical field, is very theoretical. He said that if you give students a problem and access to a computer, they'll go work like mad. However, once they get on the job they won't really know what to do, they won't know how to direct a project in which they're supposed to build something. They won't have any of those skills. Thus it seems that the problem is a general one with the universities and that we may have to get back to the practices of the old days when laboratory instruction was emphasized. It was noted that not only women might have these problems, but that foreign students are quite similar in their lack of skills. Their needs should be taken into account and taken care of. We also discussed whether women should be segregated into special programs, and the opinion among the members of our discussion group, excluding me, was that they didn't think that women should be segregated into special groups. Those who had worked in engineering for a while pointed out that when women get into the field they're often going to be the only women around and are going to experience these problems. If they can't take it as students they're not going to be able to take it as working engineers. That's not my feeling. I feel that we have to help these young women get started. It seems to me that when they're young the pressures are very great and if we can help women students over this first hurdle, they'll be able to help themselves over later hurdles.

Group III

Dennis Shay: One of the questions we discussed was "Should women be segregated in the lab?" The group felt that women react differently as individuals and some can survive without being segregated. It is possible that even in an integrated lab women will tend to cluster together and form their own groups. Thus if a lab were run correctly and carefully there might be no need to segregate the women from the men. When asked, women may indicate that they feel that women should not be segregated in labs. However when put in the situation women tend to segregate themselves, possibly because they fear that they have less ability and because they don't realize that the men put on a little better show at knowing what they're doing. Another question we discussed was "In a lab situation, should women be given a choice between doing ordered, structured work and doing projects and unstructured work?" The group decided that women should not be given a choice. One shouldn't give somebody who is uncertain an opportunity to avoid an unstructured

situation, because the more uncertain one is, the more structure one seeks. If one wants to have a lab and one wants to do projects, then you've got to make them do the projects.

Group IV

Elisabeth Lyman: We discussed whether there would be a stigma attached to remedial courses for women. It appears from the Purdue experiment that women accept such courses. They're told that they need it and therefore they pursue the course with beneficial effects. On the other hand we believe that as many males as females need this type of instruction. Thus we questioned how one could present such a course for both groups and yet segregate it. Legally, are we going to be able to carry out a program like this in our universities and colleges? It was suggested that such a course could be offered and then sections in the course could be carefully assigned such that the males were in one and the females in another. We also discussed the attitudes of males in the laboratory. One of our participants from industry said that the attitude of males in industry is that females can't do some of the mechanical work. Therefore these males take over. We didn't come to any conclusions as to how to solve this problem.

Group V

Tom Hall: Our group session started by centering on the question of what programs could be given for women to give them a group feeling or feeling of identity and support. This emphasizes one effect of the lab course and goes beyond it to more general programs. We also discussed whether standard tests could be used to pick out the boys and girls who both need these types of lab programs. We discussed whether or not you need to segregate men and women in labs. The group seemed to feel that the critical ratio might be around 50/50. However, I believe that you have to segregate them completely.

* * * *

Session V: Decisions, Decisions--What Should I Do?

"Women Engineering Students and the Career Decision Making Process--How Can it be Improved?"

John B. Parrish

Introduction

As more women with varying career objectives enroll in engineering study, both quantitatively and relative to men, the decisions that must be made by these women, their counselors, and the faculty also increase.

This paper will be concerned with this decision-making process and some of the ways in which women engineering students can be assisted in arriving at viable decisions.

The paper will draw on three sources. One is the findings of a questionnaire sent to about 50 women who graduated in engineering from Cornell and the University of Illinois in the last five years. A second sources is a mail questionnaire survey of 12,600 University of Illinois graduates from 69 disciplines (including 11 engineering specialties) in 1973 concerning their job experiences in 1974. The third source is recent published research on the problems of women, who, in the undergraduate years, opt for high level, long term careers.

I should like to raise the issues involved in this subject by posing them in the form of seven basic questions.

Seven Basic Questions

Question 1. Can Women be encouraged to obtain engineering degrees with Confidence?

This question is really two. First, in the outlook for engineers sufficiently favorable to justify counselors in urging women to complete engineering training? Second, have discriminatory policies and attitudes relented to the point competent women engineers may reasonably expect challenging and equal job opportunities?

The answer to the first question appears to be "yes." Numerous estimates to future demand add up on the favorable side with due allowance for increasing sensitivity of demand to changes in the business cycle and changing national priorities.[1]

Within this generally favorable picture there may be some problems ahead at the doctorate level according to the latest projections of the National Science Foundation.[2] The American Chemical Society has also raised some doubts about the supply-demand ratio ahead for doctorates in chemical engineering.[3] These are demand sectors the engineering profession will want to monitor very carefully over time.

Through the last two years of the worst recession since the end of WW II, engineering demand has held up extremely well relative to

other disciplines.

Let me cite the evidence from just one survey. The University of Illinois sent a questionnaire on 1974 job experiences to 12,600 graduates of the Class of '73.[4] The questionnaires were sent in February 1974 with a cutoff date of July 1, 1974. The students graduated from 69 disciplines. How did the 11 engineering specialty graduates compare with the other 60 fields? Extremely well. Let me summarize the findings:

Unemployment. The engineering graduates had very low unemployment rates, almost all below average. Graduates from four specialties reported 0 unemployment and three reported less than three percent compared to the University-wide rate of nearly five percent.

Underemployment. All 11 engineering specialties were below average in their underemployment rates. Three had zero underemployment rates.

Jobs Related to Majors. Almost all engineering students obtained jobs related to their majors. Three specialties had 100 percent of graduates in jobs related to engineering and six others had from 92 to 97 percent of graduates in engineering jobs. This is in sharp contrast to some of the social sciences, arts and humanities that had a majority of graduates in jobs not related to college major.

Salaries. The engineering graduates obtained among the highest salaries of students graduating in the 69 disciplines. All 11 engineering specialties were in the top 20.

Job Satisfaction. In terms of job satisfaction the engineering graduates were among the highest among the 69 disciplines. The 11 engineering specialties were all in the top 20 disciplines.

This survey is reinforced by similar studies in other institutions.

In sum, the outlook for women in engineering appears to be very, very good relative to all other fields, based on recent experience in a recession period.

The answer to the second question, the demand for women engineers in particular, can also be answered affirmatively. The barriers to women entering engineering employment have been falling very fast. In fact, we may have come full circle. There are probably many instances recently in which women may have actually been favored. There are numerous reports that women graduating with bachelor's degrees have obtained somewhat higher salaries than men.[5] Reports from engineering placement officers throughout the country reinforce this view. It unfortunately remains a fact that most counselors at the junior and senior high school level remain ignorant of, or poorly informed about, the new opportunities for women in engineering.

Question 2. Are women engineering students made aware of the versatility of engineering training for a wide variety of careers?

Engineering is more than just a discipline with many specialties.

It is a springboard to many other nonengineering career options, probably more so than any other single discipline. Women students need to be made aware of these options.

Let me illustrate this point by contrasting dentistry with engineering. In dentistry there are no first and second level degrees that are marketable. The first professional degree is the D.D.S. In obtaining the D.D.S. the student has few options in terms of specialties. (Table 1). There are only five. And once the degree is earned it is not transferable. One either stays in dentistry or one loses all the years of training. The student's decision making is simple. Either go into dentistry and stay, or not. The counselor's role is minimal. There is little need.

Now consider engineering. The Engineers Council for Professional Development recognizes 26 specialties. A student has a marketable degree at three different levels. And the career options are many. To counter the 26 engineering specialties, I selected 26 careers being pursued by University of Illinois engineering graduates. (Table 2). There are many more than 26.

How many women engineering students are aware of these career opportunities in making their decisions? How many counselors are aware of them and counseling students about them?

One of the Cornell-UI respondents said:

> "As for the possibilities of combining engineering with other career options--my counseling can only be described as non-existent. I did learn about some of these options, but only by chance."

Another respondent, who now has a very high paying, managerial job wrote as follows:

> "I had excellent training in engineering but there was no information readily available on the courses of development that engineering might take. I have discovered from experience that engineering management is my preference, but I was unaware as a college senior, that this was one of my alternatives. If I had been better informed I might have been able to prepare myself better in advance for the work I am presently doing. Further I was unaware of the various types of engineering firms and the gross differences in the way they function."

Table 1 Education and Career Options for Students in Dentistry

Bachelor's Degree Options	Master's Degree Options	Doctor's Degree (D.D.S.) Options	Career Options
None-pre-medicine required	None	General Orthodontist Dental Surgeon Research Dental Engineering	Dentistry

Question 3. Is the marriage vs. career conflict still a major problem?

The evidence on this question indicates that the career vs. marriage decision is not only a major decision making problem, but is probably more significant today than 20 years ago. Many of the women engineers of 25 years ago were pioneers. Many did not marry. If they did they married rather late in life. Few had children. Very few followed in the footsteps of that woman engineer, the late Lillian Gilbreth, author of Cheaper by the Dozen. The oncoming generation of women engineers is much more career-marriage-children oriented. At the Henniker Conferences, sponsored by the Engineering Foundation and Society of Women Engineers, this problem appeared to be uppermost in the minds of the undergraduate women engineering students.

What does recent research tell us about the dual career style of living?

On the positive side, women who wish to combine a demanding profession with marriage and children do have some advantages today over women making such decisions a generation ago. There is more societal acceptance of dual role. There is probably less criticism by men, and other women, about raising children with household help. There are more commercial housecleaning services available to lighten the homemaking load. Flexible shopping hours, convenience foods, are a help. These are all pluses and it is good to have them.

On the neutral or negative side however are many other factors. It is true the dual career style may be highly rewarding. It may provide the best of two worlds. But all research comes to the conclusion that the two career family style is not easy, especially if there are children.

Table 2 Education and Career Options of Engineering Students

Bachelor's Degree Options*	Master's Options	Doctor's Options	Career Options
1. Aeronautical	-	-	1. Accounting
2. Aerospace	-	-	2. Airline pilot
3. Agricultural	-	-	3. Architecture
4. Architectural	-	-	4. City Management
5. Biomedical	-	-	5. Construction
6. Ceramic	-	-	6. Dental Engineering
7. Chemical	-	-	7. Design
8. Civil	-	-	8. Elec. Data Processing
9. Electrical	-	-	9. Engineering (many specialties)
10. Electronic	-	-	10. Environmental Protection
11. Engineering Physics	-	-	11. Exploration-Mining Oceanographic
12. Engineering-General	-	-	12. Finance
13. Engineering Science	-	-	13. Hospital Administration
14. Environmental	-	-	14. Law-Patent Law
15. Geological	-	-	15. Management-General
16. Industrial	-	-	16. Medical Engineering
17. Materials	-	-	17. Military
18. Mechanical	-	-	18. Park Management
19. Metallurgical	-	-	19. Research & Development
20. Mining	-	-	20. Safety Management & Inspection
21. Naval Architecture & Marine Engineering	-	-	21. Teaching
22. Nuclear	-	-	22. Technical sales
23. Petroleum	-	-	23. Transportation
24. Sanitary	-	-	24. Urban Planning
25. Systems	-	-	25. Urban Renewal
26. Textile	-	-	26. Vet. Medicine

*Accredited Engineering Curricula recognized by the Engineers Council for Professional Development. Some schools offer additional curricula under various titles as: Computer Engineering, Electric Power Engineering, Energy Conversion, Engineering Design, Environmental Health Engineering, Management Engineering, Manufacturing Engineering, Natural Gas Engineering, Ocean Engineering, Thermal and Environmental Engineering, Transportation Engineering, etc.

For the dual career to work out successfully certain basic conditions must exist--at least for most women. These include the following:

> First, the young woman engineer must have the full support of the husband. Without it, either the career or marriage will likely fail.
>
> Second, the dual career woman engineer must be a very highly organized person both at work and at home. Time becomes the most precious element.
>
> Third, demands on energy can become very heavy, hence a married woman engineer will need abundant, perhaps super abundant energy.
>
> Fourth, a dual career woman must be very highly motivated, she must want this life style very, very much. She must be aware of the difficulties, expect them, plan for them.
>
> Fifth, she must be prepared for criticism from some men and women, including friends and relatives, especially if she has small children. The older generation is not yet fully accommodated to the dual career style. If sensitive to this criticism a nagging guilt complex can be debilitating.
>
> Sixth, she must recognize that complete absorption in work and home will limit participation in the usual social affairs of the community--the country club set, etc., and have no regrets at this limitation.

How can counselor's advise on this complex problem? Or should they try to? And how do undergraduate women sort out all the pros and cons for themselves in making decisions? There are two helpful steps that may be taken. One is to provide more women engineering faculty as models and to bring to the campus women who are successfully combining career and marriage and children. Second is to acquaint undergraduate women with the literature on dual careers. Discussions by women careerists on how they managed to resolve many of the problems of the dual career life style, can be extremely helpful. As an aid to anyone interested, I have attached a selected list of readings on dual careers for women as Appendix I.

Question 4: <u>Do women need more support and encouragement from counselors and faculty than men?</u>

It might be assumed that, since engineering is still non-traditional training for women, that these women who do decide on an engineering career, are unusually bright, which they are, and are unusually determined in career goals. The latter is true, too. From this might follow the assumption that women undergraduates in engineering (and science) need no more support and encouragment than men.

This last assumption is not true. There is abundant research available that these young women do need more assistance than men. They need more affirmative interest from faculty. They need to be brought into the informal faculty-student relationships. They benefit from special seminars with peers on mutual problems. They need more discussions with practicing women engineers.[6] As Martha S. White has put it: . . ."they need sponsors more than men. . .so much of academic learning is 'caught not taught.' . . .they need to be made members of the club" . . .more than men.[7]

Question 5. Are women engineering students, like women in other disciplines, hung up on the "afraid to fail-afraid to succeed" syndrome?

A few years ago, Matina S. Horner, in her doctoral research, advanced the thesis that bright women, especially in the sciences and engineering, were caught in a double bind.[8] They were afraid to fail. To do so would mean they didn't use their capabilities to the utmost. They let themselves down. Yet they were also afraid to succeed. They hesitated to perform as well as they could, because men would say--"she thinks like a man"--and this would bring loss of femininity.

When I first read this thesis I was frankly skeptical. Some months ago I tested this thesis out with two sets of undergraduates. One was comprised of 50 girls from many disciplines in a class on "Women in the Labor Market." The other group of 50 were undergraduate women in engineering. A majority of respondents in both groups said they observed this syndrome among other women students and they themselves often held back in classroom discussion so the professor and male colleagues would not think them too aggressive and unfeminine.

If this syndrome exists, and it apparently does, then counselors and faculty should be made aware of it and provide the support to overcome it.

Question 6. Do many women students believe they are still considered second class students despite affirmative recruitment of women into engineering?

Probably some women engineering students do not think so. But judging from the Cornell-UI respondents, many do, and these are the graduates of the past five years.

One respondent said:

> "I don't think my professors ever took me seriously."

Another said:

> "The most depressing experience I had in some engineering courses was to learn that the faculty expected less of me than my male colleagues. This gives one a sense of inferiority that is hard to overcome."

Others went on to mention how a double standard is applied in various ways. On this point, counselors of women engineering students

could make a constructive contribution by pointing out to faculty the wrongness of this approach. They used the wrong strategy.

Question 7. Will women engineers, when employed, likely experience special problems of sex stereotyping about which they need to be counseled while still in school?

I did not ask this specific question in my letter-questionnaire to the recent graduates. But in reading the replies I was impressed by the number who volunteered comments on it. The gist of the replies was, that despite affirmative action programs, greater acceptance, less self-consciousness, young women engineers still experience difficulties in being fully accepted by many male colleagues and should be prepared to deal with the problem.

One respondent put her experience this way:

> "I was not aware of some of the problems a woman will very likely encounter. Mainly I have found that even though I make a point of being assertive, yet reasonable, there are always some male colleagues who (despite their best efforts to appear otherwise) feel threatened by my very presence and my professional competence. I feel young women should be prepared to deal skillfully and tactfully with situations such as this. It may make or break their career."

In Summary

Women can be encouraged to undertake and complete training in engineering with confidence. The demand outlook is favorable.

Many women students are apparently unaware of the wide variety of career options that exist for women (and men) trained in engineering. Counselors need to provide more career information than they have had in the past.

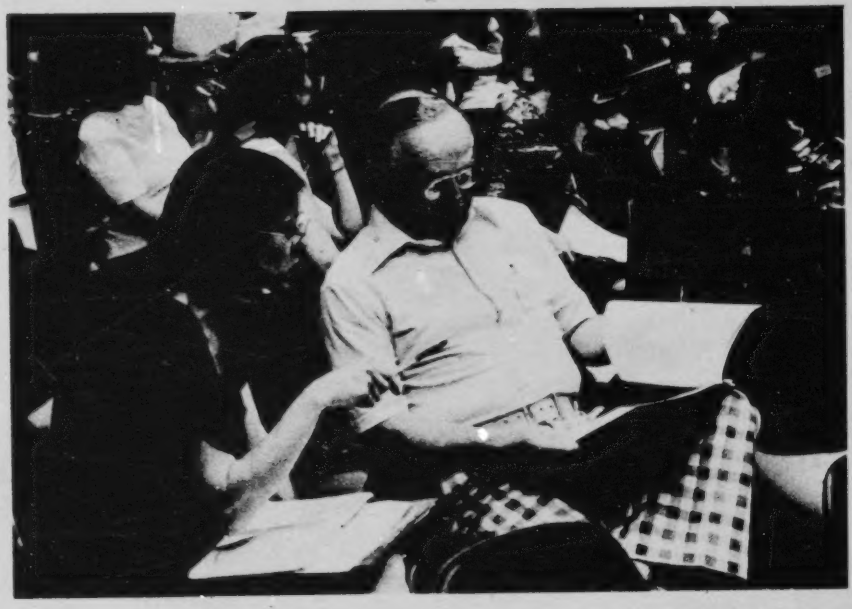
The career-marriage conflict is very real and very pressing. Here again counselors can make a constructive contribution by bringing in role models, holding seminars, encouraging women students to explore the dual career literature.

Women engineering students do need more support from counselors and faculty than men.

The "afraid to succeed" syndrome apparently does exist among many very bright women, including women engineering students. Counselors and faculty should be made aware of its existence and work to overcome it. There are numerous role models available to demonstrate that women with high expertise do not lose their femininity.

Some women students do consider themselves as second class students, apparently in part due to misguided efforts of faculty to "go easy" on women students. Counselors should work to change this attitude of faculty.

Despite rapid sex destereotyping of efforts by government, industry, academic, many women engineers will encounter difficult work problems because of sex and should be prepared for this while still in engineering training.



Footnotes

1. See, e.g., Alden, John, "Engineering Manpower, Present and Future", in The Human Resources of Science and Engineering: Today and Tomorrow. A Symposium at the 1975 Annual Meeting of the American Association for the Advancement of Science, Wasington, D.C., January 27, 1975, Scientific Manpower Commission, Washington, D.C., February, 1975, 100 pp.; The Institute of Electrical and Electronics Engineers, Inc. Career Outlook in Engineering. The Institute, New York, 1973, 223 pp. The favorable outlook is also confirmed by the recent study (March 1965) of the Engineering Manpower Commission: The Demand for Engineers, October 1974.

2. National Science Foundation. Science and Engineering Doctorate Supply and Utilization 1980 and 1985, (NSF 75-301), GPO, 1975.

3. American Chemical Society. Professionals in Chemistry 1974. The Society, Washington, D.C., 1975.

4. Office of Career Development and Bureau of Institutional Research, University of Illinois, Career Patterns of the Illinios Graduates, Class of 1973 (Sections A and B). Urbana-Chamapgn Campus, 97 pp.

5. See, various reports of the College Placement Council; the Annual Frank Endicott Survey, Northwestern University; Kaufman, Harold G., in New Engineer, February 1975, pp. 31-36.

6. See, e.g. American Association of University Women , the Association of American Colleges and the Cooperative College Registry, Graduate and Professional Education of Women. Proceedings of a Conference, May 9-10, Washington, D.C., 94 pp; Feldman, Saul D., Escape from the Doll's House: Women in Graduate and Professional School Education. A report for the Carnegie Commission on Higher Education. McGraw-Hill, 1974. 208 pp.

7. White, Martha S., "Psychological and Social Barriers to Women in Science," Science, 1970, pp. 413-416. See also, Bernice T. Eiduson and Linda Beckman (eds), Science as a Career Choice: Theoretical and Empirical Studies. Russell Sage Foundation, New York, 1973, 735 pp.

8. Horner, Matina, "A Bright Woman is Caught in a Double Bind. . .She Not Only Worries About Failure But Also About Success," Psychology Today, Vol. 3, No. 6, 1969, pp. 36, 38, 62. See also, O'Leary, Virginia E., "Some Attitudinal Barriers to Occupational Aspirations in Women, Psychological Bulletin, Vol. 81, No. 11, 1974, pp. 869-82.

APPENDIX I

The Dual Career Family: An Emerging Life Style?

The Dual Professional Family: Summary of Research. Margaret M. Poloma and T. Neal Garland. Business and Professional Women's Foundation, Washington, D.C.

"Women Lawyers: Mythology and Fact: The Nordby Report." Lucinda Lee. Stanford Lawyer. Winter, 1972-73, pp. 14 and 21.

"A Three in One Job: Doctor, Wife, Mother, Can it Be?" Dorothy V. Whipple, M.D. Occupational Outlook Quarterly, Vol. 13, No. 4, Winter 1969, pp. 4-5.

"More than a Mother." Jhan and June Robbins. Redbook, May 1969, pp. 99ff.

"Managing a Practice and a Home Simultaneously," Joanne D. Denke, M.D., The Woman Physician, Vol. 25, No. 1, January 1970, pp. 33-36.

"Dual-Salary Lifestyles." Family News and Features. Institute of Life Insurance, New York City, December 7, 1973.

The Two-Career Family. Lynda Lytle Holmstrom. Schenkman Publishers, 1972.

"Jobs or Careers: The Case of the Professionally Employed Married Women," Margaret M. Poloma and T. Neal Garland, in Family Issues of Employed Women in Europe and America. Handress, Michael and E.J. Brill (eds.) 1973.

"Men, Women and Work: Reflections on the Two-Person Career," American Journal of Sociology, Vol. 78, No. 4, January 1973, pp. 852-872.

Getting Yours: How to Make the System Work for the Working Woman. Letty Cottin Pogrebin, McKay, 349 pp., 1975.

"The Professional Woman as Mother," Lois Wladis Hoffman, Women and Success: The Anatomy of Achievement (Ruth B. Kundsin, ed.) William Morrow, 1974, pp. 222-228.

"Family Constraints on Women's Work," Lotte Bailyn, Women and Success: The Anatomy of Achievement, William Morrow, 1974, pp. 94-102.

"Being a Working Wife: How Well Does it Work?" Caroline Meyer, Reader's Digest, 102: January 1973, pp. 132-135.

American Women: A Story of Social Change. Robert E. Riegel, Farleigh Dickinson University Press, Rutherford, New Jersey, 1970.

"Two Careers and One Family: Potential Pitfalls and Certain Complexity" Papers in Women's Studies, University of Michigan, Vol. I, No. 3, October 1974, pp. 44-54.

"Men, Women and Work: Reflections on the Two Person Career," Hanna Papanek, American Journal of Sociology, Vol. 78, No. 4, January 1974., pp. 852-872.

Escape From the Doll's House: Women in Graduate and Professional School Education, Saul D. Feldman, Carnegie Commission on Higher Education, McGraw-Hill, 1974 (particularly Chapters 4-7, pp. 77-140)

"Double Jeopardy: The Working Motherhood Trap," Roberta Brandes Gratz and Linsay Van Gelder, Redbook, Vol. 143, No. 3, July 1974, pp. 38, 40, 42.

The Woman Doctor, Patricia H. Beshiri, Cowles Book Company, New York, 1969 (particularly Chapter 4 "Medicine and Motherhood, pp. 27-35)

"Working Partners: For Married Couples Two Careers Can be Exercise in Frustration," Mary Bralove, Wall Street Journal, November 13, 1975, p. 1 and 19.

John B. Parrish

John B. Parrish received both his B.A. degree (in 1934) and his Ph.D. (in 1938) from the University of Illinois. He is presently there as Professor of Economics in the College of Commerce and Business Administration at the Urbana-Champaign campus. Included among Dr. Parrish's numerous publications concerning women in the labor force are several dealing specifically with women in engineering and science. The Society of Women Engineers honored him with the Rodney D. Chipp Award for Distinguished Service to Women in Engineering. He has held advisory positions with the American Association for the Advancement of Science, the National Association of Manufacturers, the American Management Association, the University of Illinois Committee on the Status of Women, the U.S. Dept. of Labor, and the Illinois Governor's Manpower Office.

Decision Making by Female Undergraduates in Engineering: Patterns, Problems, and Programs

Robert E. Gardner

To design an effective advising system it is essential to understand the decision making processes confronting the student population. One reason research was undertaken at Cornell was to collect decision making information about males and females in engineering to determine whether the current advising system was appropriate for both. The CSQ (part 1),[1] the ACE Co-operative Institutional Research survey,[2] and the Cornell questionnaire[3] provide data for five main decision areas: choice of college program, choice of college institution, selection of major within a college, plans for graduate study, and career plans and vocational choice. Questions relating to these subject areas evaluate the timing of the decision, the resources consulted in making a decision, subsequent sources of support for a decision, and the factors rated important in making a decision. In addition, the CSQ provides scale information on peer independence and family independence.

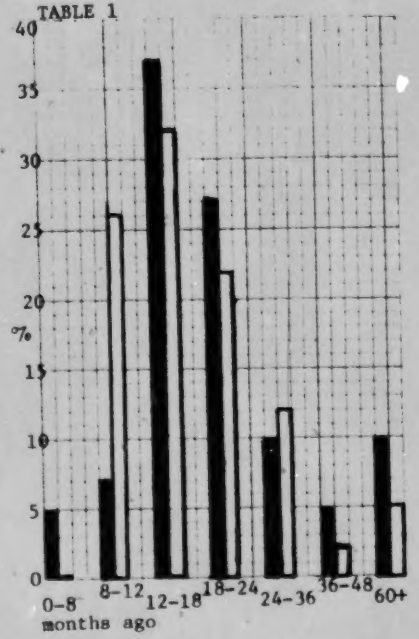
Table 1 represents the decision making patterns of males and females with respect to time in three areas: a) when engineering was first considered, b) when engineering was decided upon, and c) when graduate work was first condidered. Figure 1-a suggests that the percentage of males and females first considering engineering at any given time is about the same, except for the 8-12 month period before matriculation, when the percentage of women first considering is much higher. This probably reflects the recruiting efforts of engineering institutions, since this is the time period when recruiting is most active, particularly blind recruiting by mail from achievement score lists, etc.

The proportion of females considering engineering in this period may reflect the fact that females in general do not consider college plans as early as males.

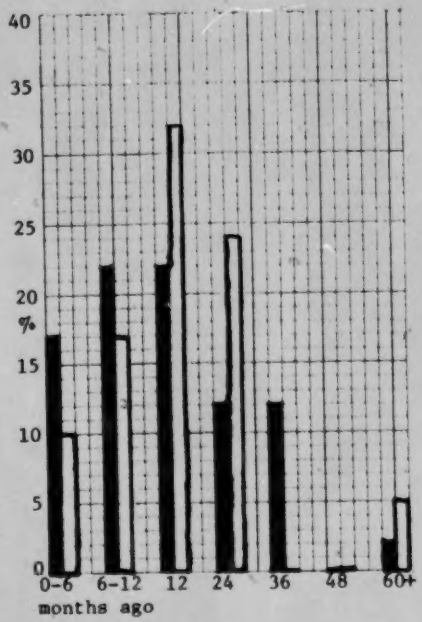
The fact that males are generally ahead of females in the early stages is almost certainly the result of the greater parental pressure for a college decision that males reported in this survey, assuming this would manifest itself by parents placing "possibilities" or "opportunities" before their sons at an early stage. Given this, the relevant point is that the females are as close to the males as they appear to be, for this strongly suggests that the majority of the females in this sample are treated no differently than males by their parents.

Table 1-b shows that the time pattern for males and females in deciding on engineering is considerably different, with decision making by males dispersed evenly over the three years preceding matriculation and continuing up to the last moment, whereas females concentrate their decision making in the period 24 to 6 months preceding matriculation. Given the times at which males and females first consider engineering as reported in 1-a, one concludes that the females complete their decisions much faster than the males. Females report considering engineering in the same time period, i.e. the percentage of females deciding on engineering 12 months prior to matriculating is the same as the percentage considering engineering 12 to 18 months prior to matriculating. For males, however, there is an appreciable time shift, i.e. though a high percentage consider engineering in the 12 to 18 month period, a

TABLE 1

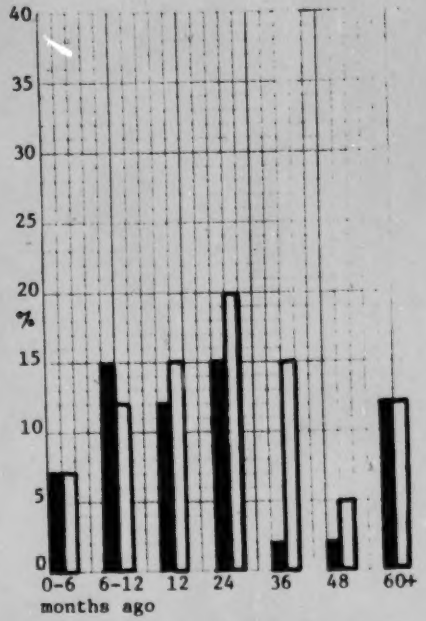


(a) When did you first consider engineering as a possible choice for your collegiate program?



(b) How long ago did you decide on this field? Do not consider specialties within a field (e.g. teaching or engineering).

(p=.1175)



(c) When did you first consider the question of graduate or professional training?

(p=.8021)

♀ ▭

♂ ▬

lower percentage report deciding during the 12 month period, resulting in higher percentages in the 6-12 and 0-6 month range.

Responses to other questions show that females utilize considerably more resource persons in making a decision than males, hence it appears that females are active in their decision making once a choice is presented to them, in preference to letting the decision go unresolved.[4]

Females also report that support for their decisons is very important and many seem to prefer some structure or other source of personal orientation, suggesting that females may view a decision left hanging as an area of uncertainty or conflict in their lives, and hence take steps to remedy the situation.[5] Males, on the other hand, reveal a strong urge for independence in making decisions, their tendency to make decisions later may stem from a belief that making a decision late signifies freedom and independence. Presumably consulting too many resources too early conveys an impression of uncertainty which presumably is the wrong image as far as males are concerned.

Table 1-c also shows considerable difference in the time patterns of males and females in considering graduate work. More females consider graduate work three or even two years prior to matriculation; about the same percentage of males and females consider graduate work in the year prior to matriculation. When Figure 1-c is compared to 1-b, it appears that many females consider graduate work before they decide on a professional career, a pattern that is clearly different from that of the males. This suggests that females do not consider graduate work for the professional or career rewards it might bring, but seek graduate training for other reasons.

This is explainable in terms of the female response throughout the questionnaire, which demonstrates a very strong attraction to academic achievement--and a very strong record of successful achievement in secondary school.[6] Because they prove their strength as students early, females may view graduate work as a natural "career", one they believe they can be successful in pursuing because of their success thus far, and one that will allow them to maintain the intellectual component that is the focal point of their interest. Males, on the other hand, probably have not demonstrated the requisite academic success by the end of their freshman or sophomore year, are less academically mature, and have not considered graduate work because they relate that decision to choosing a major or a profession. Males apparantly consider graduate work simultaneously with or after deciding on a college major because that decision is a consequence of career patterns within a field.

The final decision in regard to graduate work also varied considerably between males and females with 86 percent of the females indicating they "will" or "probably will" undertake graduate study, compared to only 68 percent of the males. The difference of 18% is probably misleading in the sense that graduate work for engineers is of two types, one being the traditional MS-Ph.D. program and the other being the professionally oriented Masters. Since males select engineering for reasons in addition to an intrinsic intellectual interest, we can hypthesize that "graduate work" may be equated with the professional Masters program (which offers professional returns for the time invested)

rather than an MS-Ph.D. program.[7] This appears to be the case, as 46 percent of the females reported they planned to receive a Ph.D., compared to only 20 percent of the males. Additionally, a considerably larger fraction of females reported plan to undertake a graduate degree outside of engineering, particularly in law and medicine. One concludes therefore, that the decision making of males and females with respect to graduate work is different in timing and motivation and reflects the reasons the two groups select engineering as a college program.

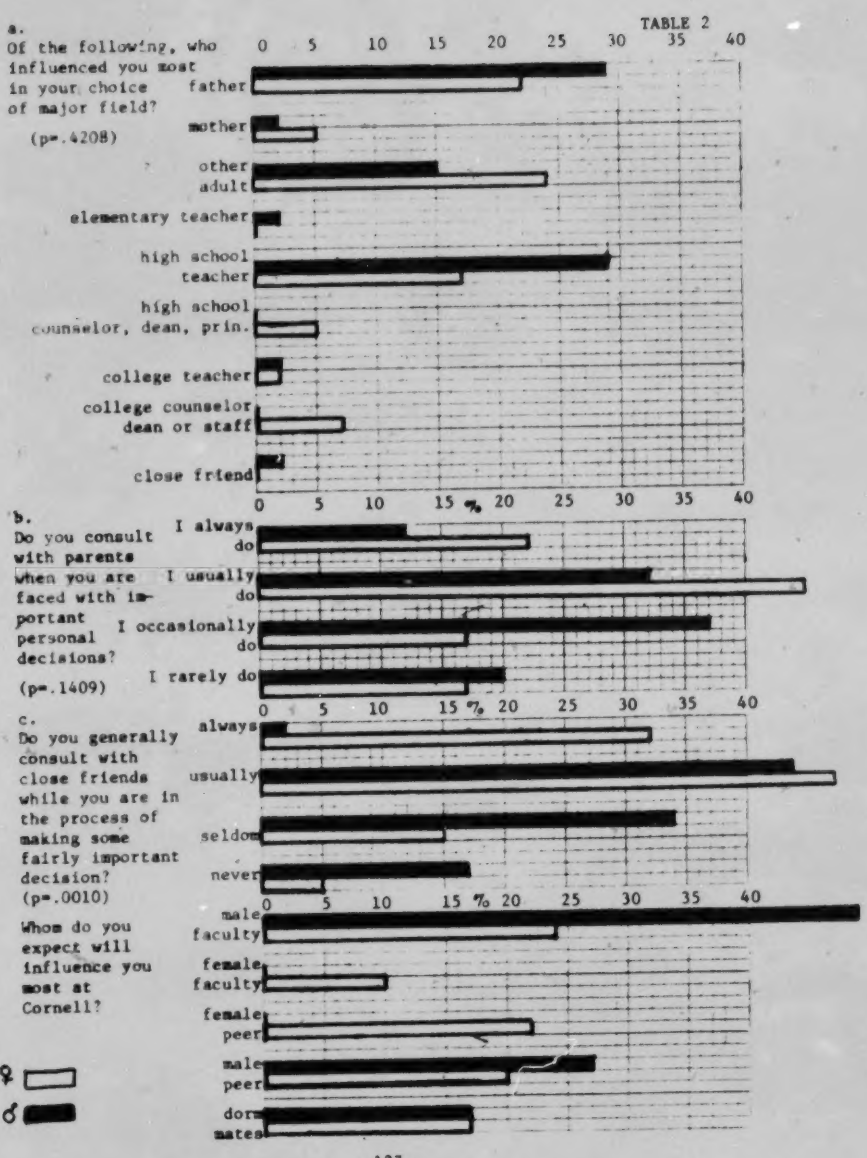
Data concerning the process of selecting a field within engineering by males and females is not available in the literature. Institutional data for Cornell is gathered through individual responses recorded on the student data summary sheet compiled for each matriculant, with the choice indicated reflecting a decision completed by the senior year in high school.[8] For the classes entering since 1972, on the average 18% of the females indicate they are undecided, compared to 13% of the males. The slightly higher proportion of undecided females is hardly surprising in view of the response of 20% of the females that they first considered engineering during this time period.

At Cornell, students do not matriculate in a Field until their junior year, making it possible to determine whether students follow through on their original decision and thus gauge if males or females as a group seem to be changing their decisions. The data for the class entering in 1972, the only data available at this writing, show no difference: 32.2% of the females entered the field they originally named, compared to 31.2% of the man. Consequently, the oft-repeated claim that females are much less set in their plans within engineering is not true. Both males and females are unset in their plans. This evidence indicates that neither sex is capable of making a lasting decision in this area, and that where a split curriculum occurs, assistance in selecting a Field should be a major thrust of advising systems for both groups.

Table II summarizes the attitudes of males and females toward three resources available in decision making: parents, peers, and faculty/staff. Figure 2a shows that "fathers", "other adult acquaintances", and "high school teachers" were the most influential for both males and females in selecting a major; however, while fathers were cited about equally by males and females, females cited "other adults" more frequently than the males did and more frequently than "high school teachers"; the pattern for males was reversed. Since females in this sample reported closer relationships with a larger number of high school teachers than males, their failure to utilize this resource as frequently as males is important, since this suggests that females do not consider high school teachers knowledgeable in this area. Females also cited high school counselor, dean or administrator and college counselor, dean or administrator as influential, but males did not cite these at all.

Figure 2b shows that two thirds of the females consult their parents routinely in making a decision; three-fifths of the males consult their parents only occasionally or rarely. Figure 2c shows that four-fifths of the females consult their close friends routinely in making a decision whereas half the males seldom or never consult friends in making decisions. Figure 2d indicates that females plan to consult a

TABLE 2


a.
Of the following, who influenced you most in your choice of major field?
(p=.4208)
father
mother
other adult
elementary teacher
high school teacher
high school counselor, dean, prin.
college teacher
college counselor dean or staff
close friend
0 5 10 15 20 25 30 35 40
b.
Do you consult with parents when you are faced with important personal decisions?
(p=.1409)
I always do
I usually do
I occasionally do
I rarely do
0 5 10 15 % 20 25 30 35 40
c.
Do you generally consult with close friends while you are in the process of making some fairly important decision?
(p=.0010)
always
usually
seldom
never
0 5 10 15 % 20 25 30 35 40
Whom do you expect will influence you most at Cornell?
male faculty
female faculty
female peer
male peer
dorm mates
♀
♂

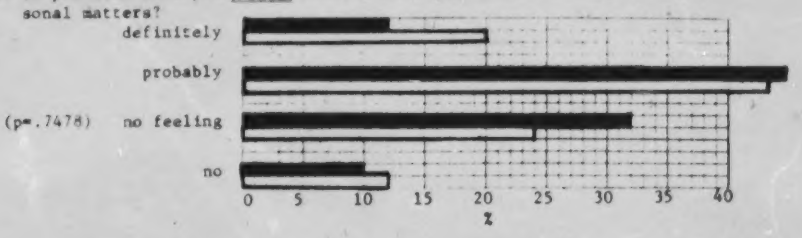
spectrum of resources in making decisions on campus, both male and female; males plan to consult only males.[9] Taken together, Figures a,b,c, and d suggest that females consult many resources in making a decision and consult these resources more frequently; in contrast, males consult fewer resources and these far less frequently. One concludes, therefore that the basic need for advice is substantially greater for females, and that they are potentially heavier users of advising resources.

Table 3 indicates that females do not perceive consulting any of these resources as dependence; on the contrary, even though females consult these resources more heavily they perceive themselves as being less dependent than males. This suggest that males equate seeking advice with dependence, whereas females do not view consulting resources in the same way. If, therefore, males regard independence as a desirable thing, which their response to other questions in the survey indicates they do, we can explain why they consult available resources far less often and we can project difficulties for an advising system that depends on their initiative to come to resources, rather than sending or mailing advising material to them.

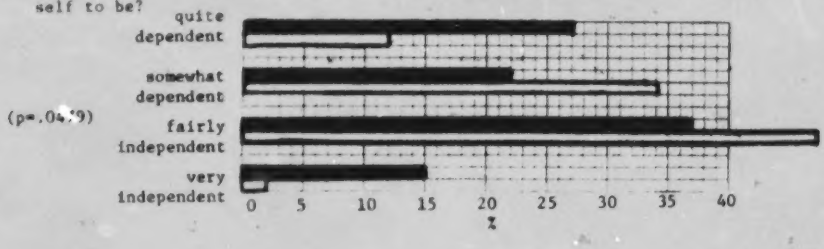
Decision making is also affected by perceived support because decisions may be effectively negated or reversed when support is not present. In one decision area we are reviewing here, selection of a major, Sandra Davis has shown that subsequent support has a marked effect in retaining females within a major or curriculum.[10] Responses to the CSQ show considerably different patterns of parental support in the choice of major: 76% of the females reported their parents "strongly approved" compared to 46% of the males; 14% of the females reported their parents "mildly approved" compared to 32% of the males. This pattern of strong support for females was confirmed in the Cornell questionnaire, with the results on parental support similar to the above. Support from guidance counselors was similar for both groups: 32% of the females reported strong support compared to 20% of the males, and 30% of the females reported mild support compared to 41% of the males. The Cornell questionnaire also evaluated the effect of "Cornell's encouragement" on the decision to pursue engineering: 27% of the females rated such support very important compared to 2% of the males; 37% of the females regarded such support as important, compared to 27% of the males. This suggests that females need and receive strong support for decisions. However, it is not certain that there actually exists more support for females. The reported strong support for females may reflect a difference in perception: for example, 24% of the males perceived no support from Cornell compared to 10% of the females, even though the admission/recruiting/support process was virtually the same for both groups. Hence, it appears that females differ from males in their perception of support, so that the same support recorded as strong support by females may not be noticed by males. Consequently, if little of no support is available it is not likely to affect the male population because of their insensitivity, but it could have a far reaching effect on the females because of their far greater sensitivity.[11]

The instruments used at Cornell also provide an insight into a fourth area, the factors taken into account in making a decision. For females, the intellectual side of life is the most important factor: their intrinsic interest is the prime reason for selecting engineering;

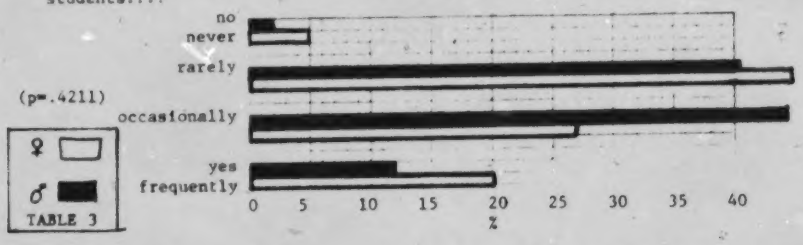
a. Do you feel that you <u>should</u> consult with your parent on important personal matters?



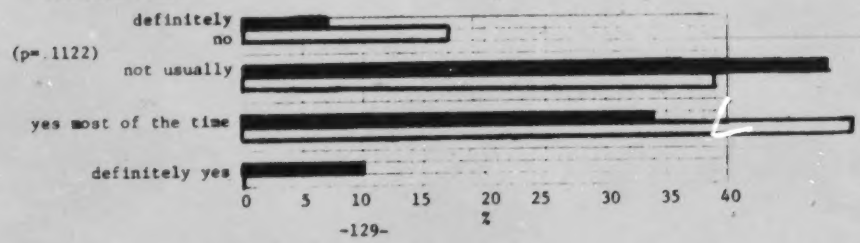
b. How dependent on or independent of your parents do you consider yourself to be?



c. Would you say that you often seem to ignore the opinions of other students...?



d. Do you generally like to do things...without regard for what other students...think?



it is probably the basis for their choice of major, probably responsible for their plans to go to graduate school in greater numbers, and almost certainly a factor in their choice of institution, since nearly one third of the females indicated that "special educational programs" were important in selecting Cornell. A second important factor is the desire to help others; this is the reason cited by almost half of this sample as the most important for selecting engineering and it is probably the factor motivating females to select certain fields in engineering, such as environmental engineering, with greater frequency than males. A third important factor for females is family; 80% of the females respond that they "definitely could not" or that "it was extremely unlikely" they would forsake family for their own activities.

The intellectual component is important for males too, but not as important as it is for females, as few males wish to be remembered, for example, as a student, or see the academic orientation as the more accurate descriptor of themselves. For males, financial reward, chance for advancement, stable secure future, and freedom from supervision are important factors that impinge not only on the decision for engineering, but also affect the selection of the major (Is it true chemical engineers get the highest starting salaries?) and the decision for graduate work (How much money will I lose by going for a Ph.D.?). Males are not restricted by family ties, and feel far less obligation to engage in socially responsible activities.

The CSQ also suggests females are much broader in their intellectual interests and that this breadth affects their decision making in academic areas. Responses by males indicate little interest in classical education; males seem to be overdeveloped in the areas of science and math, which are their principle interests along with hobbies and sports. Females, in contrast, have much broader interests: their response shows them more active in drama, music and fine arts, more interested in history and the humanities, and more widely read, with a preference for poetry and novels in contrast to science fiction.

Since a major recurring decision at every institution is the selection of courses--and particularly at institutions such as Cornell where there are numerous natural/social science and liberal studies electives--the set of interests characteristic of females greatly complicates the decision making process. For females, the number of potential choices is enormously large and to cope with the situation a philosophy akin to that used by liberal arts students frequently develops, wherein the criteria utilized in reaching a decision are totally different from those cited by male engineers. Males seem to have narrower, well defined interests that often relate directly to engineering and as a result their choice of electives is restricted and often repetitive, with large numbers populating courses in basic economics, etc. and requesting courses in accounting or business law.

These differences in the decision making processes of males and females have numerous implications for advising delivery systems.[12] Females appear to be open and accessible to advising programs, and, in fact, we can safely assume that they are critical if advising resources are not available. Programs currently provided by many institutions evolved in response to male populations that operate for the less intensive male needs, and they may therefore be judged inadequate by women,

even though they have been perfectly acceptable to men. Institutions may need to upgrade advising services as a result of the appearance of significant numbers of female students.

Males and females consult different resources; consequently, the design of a delivery system will need to provide different elements if an optimal configuration is desired. In particular, systems available to women should include the following:[13]

1. Access to female faculty or staff as a source of advice familiar with female orientations to decision making and cognizant of female value sets.
2. Inclusion of parents in the advising system through an Orientation program and a periodic newsletter; since parents are frequently consulted by females, they should be as knowledgeable and supportive as possible.
3. Inclusion of upperclasswomen as peer advisers: given the tendency of females to consult close friends in making decisions, trained peer advisers might provide a resource of knowledgeable persons who might be substituted for friends.
4. A faculty development program for all faculty who advise female students. The program should include an introduction into female decision making patterns, strategies for advising female students, an emphasis on the need to support females in their decisions and a list of things to avoid.
5. A decision making calendar should be prepared for each academic year. Advisers and program planners should be aware that women seem to make decisions sooner than is required; males, on the other hand, appear to wait in making many decisions. The same person should keep in mind that females may seek advice, males may need to be sought for advising.
6. Informational advising seminars should be presented in those areas of special concern to females, including information on interdisciplinary courses of study, dual degree programs, etc. to be sure that these oft-forgotten programs are adequately covered.
7. Non-academic advising experiences, such as placing females in a professional situation for a week during intersession freshman or sophomore year, should be made available for all females, and participation should be strongly encouraged.
8. A value-clarification course should be offered as part of an engineering orientation course to help students deal effectively with value conflicts that may arise, conflicts that may be more common among females because of the values they embrace.

In addition to the above, administrators who've responsibility for advising systems should familiarize themselves with the available research to document the need for these changes and thereby provide a basis for working successfully with high-level administrators in implementing the suggested changes.

Footnotes

1. College Student Questionnaire: Part 1. Published and distributed by the Educational Testing Service, Princeton, New Jersey. This instrument was used because of the broad range of topics covered, because of the availability of national norms, and because of the ease of scoring. Since we were not sure what differences would appear, if any, we thought the broad spectrum instrument the only feasible approach.

2. Questionnaire used in the Co-operative Institutional Research Program, sponsored by the American Council on Education and conducted by the Laboratory for Research on Higher Education, Graduate School of Education, University of California, Los Angeles, California 90024.

3. The Cornell questionnaire was a forty item instrument put together by staff members in the Division of Basic Studies and the Dean of Students Office at Cornell University, primarily for use as a supplement with the CSQ. Further information is available from the Division of Basic Studies, 170 Olin Hall, Cornell University, Ithaca, N.Y. 14850.

4. See Table II below. Though the items in this area are not statistically significant themselves, the overall trend for females is quite clear, so that the set of questions does appear to have significance when viewed together.

5. The reported preference for structure or a point of orientation is a general conclusion of the Cornell staff participating in this project as a result of follow up work with groups of females, males, and male/female during the course of the academic year. There is no item on the instruments probing this area.

6. M. Ott, "Attitudes and Experiences of Freshman Engineering Students" This paper briefly summarizes the results of the research at Cornell; it was given at the conference "Women in Engineering--Beyond Recruitment" and is published in these Proceedings.

7. The College Student Questionnaire does not distinguish the types of graduate work available to engineering students. Though the Ph.D. is singled out, there is no category corresponding to the professional Masters, making it difficult to accurately determine the graduate plans of these freshmen as they relate to real opportunities.

8. This data is gathered at Cornell as part of the admissions process, and therefore represents the expectation of a major field within engineering for students in their senior year of high school. Data on the field choice of students is gathered a second time when they actually select a major at the end of their sophomore year. A comparison of the two sets of data reveals subsequent changes and decisions.

9. This response should be viewed with caution, because there are currently only two female faculty members at Cornell, and neither of these whould be visible to entering freshmen. Consequently, the

Footnotes (con'd)

category "female faculty" might have been selected far more often if the students in the sample had been aware that there were female faculty available.

10. S. Davis, "A Researcher's-Eye View: Women Students, Technical Majors, and Retention." IEEE Transactions on Education, Vol. E-18, No. 1. February, 1975, pp. 25-29.

11. This effect is noticeable at Cornell, where students in the College of Human Ecology, almost entirely female, rate the advising services of that college very critically, while the students in the College of Engineering, almost entirely male, rate the advising services of the college very well, even though the resources available in Human Ecology are much greater. Objectively, it is very difficult to believe that the sevices rendered in the College of Engineering are any greater or of better quality. The only feasible explanation seems to be the greater demands and expectations of the females.

12. I am here referring primarily to an advising system that utilizes faculty as the primary delivery agents. My comments are aimed at perfecting such a system by incorporating other elements as aides, but keeping faculty as the focus of activity. Institutions with other resources for advising may have far greater flexibility, and other design options, than the ones I offer here.

13. Though I have confined my comments to the advising needs of females, the data lend themselves equally to advising for males. Naturally, any system must serve both groups, and preferably not separately. Because the conference is focussed on women, I have directed my suggestions primarily to meeting their special needs, though I realize fully that may men share these needs as well. What I suggest is that the needs of women may be forgotten in advising systems that have evolved in response to the demands of males, and that care should be taken to include concerns expressed by women in any overall system.

"Career Interruptions and Perceived Discrimination Among Women in Engineering and Science"

Esther Lee Burks

The study with which I am associated is an attempt to answer the question, "What factors are most influential on the career decisions of women engineers and scientists?" The answer to this question is of increasing importance as the effort to recruit students in these fields gathers momentum. Responsible counseling for the woman student as well as effective use by her and by society of the education she received may be dependent on knowledge of the answer to this question. That is, the underlying interest in this study is that of developing policies which will aid the participation of women in science.

This afternoon I will present to you a part of the preliminary results of this study. Complete results will be available later in the Summer. The policy implications of the complete results are to be discussed at a two-day workshop for policy makers, primarily representing industrial sectors which need large numbers of engineers, on August 7-8.

The study is based on the final version of a survey instrument mailed in the Spring of 1975 to approximately 2,000 women--these were members of five professional societies as well as Georgia Tech women graduates in the relevant fields. The professional societies represented engineering, physics, chemistry, statistics and microbiology--groups representing a spectrum of participation rates by women, ranging from the low of 1.6% in engineering to the high proportion of microbiologists who are women. (U.S. Census, 1972 Subject Report, Occupations.) An almost identical instrument was mailed to 400 male graduates in these fields, which should allow an interesting comparison of men and women graduates. The questionnaire requested information on level of career involvement versus other activities, professional work experience, details on most recent job experience, career interruptions, sources of personal satisfaction, perceptions of discrimination, attitudes relating to the interaction of career and family life, as well as basic background information on age, family situation, and education.

Of these topics, I have chosen to share with you today our preliminary results on the career interruptions section of our questionnaire, as well as the results from the section on perceived discrimination. I would like to preface that information with an aside. We have assumed throughout most of our discussion here that women will bear the burden of balancing career and family responsibilities; that women alone will be the ones to leave school or work involvement for a time to bring up children. If opinions are antecedent to action, our respondents seem to be considering other alternatives. For example, 68% agree with the statement that "Men can raise small children just as well as women can.", while only 16% disagree with this statement. Further, fully 45% of our respondents disagree with the statement that "I personally would feel uncomfortable if my husband kept house while I went out to work.", compared to 36% who agree. Also, 41% of the group disagreed with the statement that "In a conflict between a husband's career and a wife's career, the man's career should come first.", compared to 27% who agreed with this. Most strong agreement (82%) was expressed with the statement that "When husband and wife both work, housekeeping duties should be shared

equally." These are statements that seem to reflect a strong and perhaps unconventional perception of equal rights to career pursuits, in spite of the strong (82%) agreement expressed with the statement that "Women have to do better than men to get the same amount of professional recognition." Such attitudes seem to suggest that some substantial proportion of women and men in the future may adopt what are now distinctly unusual solutions to the home/career conflict.

The first section of the results that we will discuss is that relating to the 38% (N=427) of our respondents who answered yes to the question, "Have you ever been away from professional employment for six months or more?" This topic of career interruptions is of key importance since it is of concern not only to women themselves, but also to employers--who may fear a sort of irresponsible skipping about behavior on the part of women workers, despite rather strong evidence generally to the contrary. While some professions--notably teaching, social work, and nursing, have been shown to lend themselves nicely to part-time, part-year, or even to interruptions of several years or more, the technological professions are not at this time structured so as to encourage this flexibility at any recognized level--I may say recognized level, since as we have noted here, it is evident that men as well as women do experience breaks for voluntary or involuntary reasons--military service, for example, as well as for reasons feared by employers facing the "problem" of an increase of women professionals such as pregnancy, transfer with husband, etc.

Today, I would like to share with you part of the data that we have gathered on such questions as:

1) What are the major reasons for your most recent break?
2) How long was it and how many such breaks have you experienced?
3) Have you returned to professional employment?
4) If so, what factors were most influential in this decision?
5) How did you keep up with developments in your field during the break?
6) What were the greatest sources of difficulty to you in re-entering your field?
7) If you are now working, what has been the relation of taking such a break of more than six months with your career--with income, for example, or with expressed career involvement?

Regarding our first question about major reasons for leaving professional employment, we find that, in order of frequency chosen, we have:

Rank	Number	%	Reason
1	148	34	Pregnancy
2	120	28	Desire to devote more time to family
3	95	23	Moved geographically
4	83	21	Return to school or college
5	57	13	Lost or quit job
6	37	9	Getting married
7	23	5	Changing professional field
8	19	5	Personal ill health

Respondents were asked to check any that apply, so these categories are not mutually exclusive. In spite of this overlap, we will see later that the reasons chosen have an influence on the profile of the break, particularly in the areas of length of break, and sources of difficulty in returning.

The length of break taken is of course of interest; but before discussing this variable, we note that 70% (N=280) of the women who have taken a break, have taken only one such break; 22% (N=87) have taken two such breaks; and 8% (N=35) have taken three or more. The fact that 70% have taken only one such break is encouraging in terms of sensible career planning for women professionals. Of course, not only numbers of breaks but also length of time away from the profession is of interest to us here; and we will examine that variable now.

All the answers discussed in this section refer to the most recent break experienced. The median length of break is 2 years. That is, 50% of the women who have left their profession have been away for less than this length of time. Those women who have completed such a break and had returned to employment reported a median length of break of 1year-7 months. If the break was taken for reasons of pregnancy, the median length of break was 3.5 years; if taken for more education, 1.75 years; and if taken because of a geographical move, the median was 2.2 years. Clearly, the termination because of pregnancy was associated with a distinctly longer break; and this suggests that attention should be given to such policies relating to this matter, such as maternity leave, child care facilities, and related issues.

Our third concern is with the question, "Did you return to professional employment after this break?" 72% (N=313) have returned: 9% (N=38) have decided to do so and are currently seeking work; 13% (N=56) have not, and 6% (N=20) did not answer this question. The work status of these women is distributed as follows:

15.1% not employed, and not seeking work
5.9% not employed, and are seeking work
3.8% employed less than 10 hours per week
15.4% employed between 10 and 35 hours per week
59.8% employed 35 hours a week or more

The discrepancies between the answers to these two questions suggest that a small percentage of these women are working, but are not in a professional capacity.

Of those who left for reasons of pregnancy or family matters, 72% have returned to professional employment, although only 51% are working more than 35 hours a week. Of those who left because of a geographical move, 67% have returned and 58% are employed more than 35 hours a week. Of those who left to return to school or to change professional fields, 77% have returned to professional employment and 71% are in full-time employment. Of those who lost or quit a job, 65% have returned to professional employment, but only 57% are full-time.

The marginal status of currently seeking work is rather different in distribution, according to the reasons for leaving. Only 4% of those who left for family reasons are in this status; 8% of those who left for

education; 16% of those who moved; and 21% of those who lost or quit the last professional job.

For all groups, a similar cluster of reasons is associated with the decision to return to professional employment. The rank order, which resulted from responses to the question, "Did any factors have significant influence on your decision to return to professional employment?" is as follows:

Rank	N	Factor
1	213	Wanted to get back into my field
2	181	Wanted to be with other working professionals
3	152	Bored with being just a housewife
4	141	Needed additional income
5	108	Wanted to feel independent
6	93	Received very attractive job offer
7	87	Children became old enough*
8	26	Other major change in family circumstances
9	23	Got separated/divorced/widowed

*For the 87 women who checked this reason for returning, the median age of the youngest child was 6.25 years.

It is of interest to note that for all groups the intellectual and social attractions of the profession for which they trained are the leading factors in a decision to return.

Ways of keeping current in one's field differ only slightly according to the reason for break. For the whole group, these rank in order of frequency mentioned as follows:

Rank	N	Means of keeping current
1	227	Subscribing to professional journals
2	203	Discussions with other professionals in your field
3	147	Attending professional meetings
4	121	Attending classes
5	117	Part-time work in related field
6	46	Other

While several of these items reflect the character of our sample, the high proportion of women responding to this question is perhaps related to the fact that the great majority of those who have taken a break in career have been able to return in their profession.

Our respondents who had decided to return to their professions were asked to respond to the question, "To what extent were (or are) the following factors a source of difficulty for you in getting back into professional employment?" Responses were on a scale from 1 (No problem) to 7 (A major difficulty.) The table below displays the factors, ranked in order of the sample mean, as well as sample means for each of the following categories of reasons for leaving, since these seem to show a

differential relation to these sources of difficulty: category 1 = pregnancy and family matters; category 2 = Return to school and changing field; category 3 = Moved geographically; category 4 = Lost or quit job.

Rank	X	Source of Difficulty	1	2	3	4
1	3.9	Finding a suitable job in field	3.2	3.8	4.8	5.1
2	3.4	Lack of geographic mobility	3.4	3.3	4.2	3.4
3	2.9	Finding adequate child care	3.9	2.2	2.9	2.3
4	2.5	Finding household help	3.3	2.1	2.6	1.9
5	2.1	Personal lack of confidence	2.3	1.6	2.4	2.1
6	2.0	Out of date professsional skills	2.6	1.5	2.0	1.8
7	1.8	Age discrimination	1.8	2.0	1.8	2.5
8	1.6	Unfavorable family attitudes	1.9	1.5	1.4	1.6

As one might expect, there seems to be a relation between the reasons for leaving professional employment and sources of difficulty in returning. However, for three of the four categories we have created, finding a suitable job in one's field is of first importance. Job search assistance may, at least in large urban areas, be one key way of enabling more women to realize their potential than are presently able to do so, particularly in light of the fact that the women in our study are so unusually highly qualified in terms of educational level. 37% of these women who have taken a break have a doctor's degree or equivalent, 36% have a master's; and 25% have at least a bachelor's degree. If such well-prepared women see finding a suitable job as a key problem, then women who are less well prepared are very likely to need such assistance to an even greater degree.

We will examine the effect of taking a break on three career-related variables--income and expressed career importance, for those who are now working full-time; and expressed future career involvement for those who have not yet returned. It is reassuring to note that the income of those who have taken a break and returned to full-time work is at or slightly above the mean for the whole sample of full-time workers--in the $15-20,000 category. Other interesting indications are that 37% of the women who left for family-related reasons are in the category of over $20,000 per year. However, only 18% of those who left to move geographically are in this category. 75% of these women who have returned after a six-month or longer break consider their career to be "the central overwhelming, or a very central interest" in their lives. 60% of these women rated their job satisfaction as 6 or 7 on a 7 point scale. For those who have not returned after taking a break, we are interested in their expression of future career involvement. 54% of these women believe that within the next five years, their career will become more or much more important to them than it is now.

In summary, the results from this section suggest that for this group of professional society members and graduates from our institution (1) career commitment is high; (2) length of breaks taken for various reasons are likely to be for less than two years; (3) the most influential reasons affecting the decision to return are those intrinsic to the professional situation itself; (4) finding a job and arranging for child care are seen as moderate to severe problems by many women; (5) unfavor-

able family attitudes are not perceived as a significant problem; (6) persons who leave to move geographically or because of losing a job show the most severe aftereffects; and, (7) in contrast, women who leave for family reasons evidence the least.

My final topic is not directly related to that discussed above, in that we have not compared these results on perceived differences in job-related treatment to any of the elements in the interrupted career section. However, it may be of interest for the purposes of this meeting to learn how this group of women sees the balance of treatment on the job.

First of all, it is of interest to note that on a list of eleven job-related items, the mean answer to a request to indicate a perception of differences in treatment compared to men, on a scale of 1 (much worse) to 7 (much better), no item had a mean of greater than 3.5. #4 corresponds to a perception of equal treatment. In order of farthest to closest to parity, the items ranked as follows:

Rank	X	Area	% who feel that women are treated Worse than men	Same	Better
1	3.0	Promotions	63	29	6
2	3.1	Adequate preparation for top level careers	52	38	6
3	3.4	Access to Professional jobs	48	40	12
4	3.4	Participation in important work-related decisions	46	45	7
5	3.4	Salary and Fringe benefits	45	49	5
6	3.4	Inclusion in informal work-related social activities	41	46	10
7	3.4	Travel assignments you would enjoy	39	49	8
8	3.4	Acceptance by colleagues of your decisions and judgments	41	48	10
9	3.6	Access to informal channels of communication, i.e. the "grapevine"	39	42	17
10	3.6	Formal recognition of actual duties and accomplishments	35	53	11
11	3.6	Interesting work assignments	32	58	8

The problem area that looms the largest for these respondents it promotions, with fully 63% of these women feeling that women are treated less well than men in this respect. Displaying an interesting relation to the reasons for returning to work after a break is the result that the area seen as closest to parity is interesting work assignments. As we noted earlier, the reasons most often cited as drawing women back into the work force were related to the intrinsic attractions of the profession. The overall perceived distance from parity is reflected in the agreement of a large majority of our respondents--82%--with the statement, "Women have to do better than men to get the same amount of professional recognition." Also, 71% of our respondents agree with the

statement that "It's harder for a woman than for a man to be accepted fully into a professional work group." Analysis which will not be presented here suggests that the rank order of the areas is related to the type of work in which our respondents are involved--with management, for example, having a different pattern emerge than research and development. Also related is the type of employer. For certain key items, for instance, government employees see less discrimination than do employees of private industry.

In sum, we can see, even in this cursory analysis of our data on perceptions of discrimination, that in spite of the fact that our respondents are a highly qualified, highly career-committed, highly satisfied (89% report high job satisfaction) group, differential treatment on the basis of sex is still felt to be a problem. Further, preliminary analysis of our data on the same questions from male respondents indicates that their perception is of an opposite situation--that reverse discrimination favoring women is now the case. This contrast suggests that, within an individual organization, open examination of both perceptions and realities in the areas we have covered may have a very positive effect on bringing women and men to their full potential as group members.

Esther Lee Burks

Esther Lee Burks received her B.A. in Mathematics at Georgia State University in 1972 and her M.S. in Applied Statistics in 1974 at Georgia Institute of Technology, where she is currently a Ph.D. candidate and instructor in the School of Industrial and Systems Engineering. She is also Assistant to the Dean of Engineering at Georgia Tech. As a research associate with the Engineering College from 1972 to 1974, she was responsible for the initiation and development of a program to increase the number of women in engineering. Ms. Burks has worked on two recent publications, "The Junior High Years: A Time for Beginning Research and Engineering Orientation" and "Career Decisions of Women Engineers and Scientists."

Session V: Questions and Answers

Barbara Wilson: In your survey you referred to the fact that about 30% of the men and the women don't stay in the particular field of engineering that they choose upon admission to Cornell. You referred to them as "unsettled", those who did change. The point I would like to make is that referring to those students as unsettled is somewhat of a mistake because it carries a negative connotation. I would say that most students have little or no exposure to different fields of engineering. The changing of fields perhaps indicates that they are looking at other fields inside engineering and deciding that that's where they belong.

Bob Gardner: There are two different categories here which I should explain. There is an "Undecided" group, and among the "Undecided" group, the attrition rate is twice as high as for the students who name a specific field. So I say that the former group is unsettled. The "Undecided" group is clearly what we would call a high-risk category. Now, I think what you say is true for the other group. Among those who decide, there is considerable switching. In fact we find that more than two thirds of the males and the females change their minds.

Barbara Wilson: I think I would consider the switching as a healthy sign that they're looking at the other fields.

Bob Gardner: I agree.

Barbara Wilson: You talked about setting up decision-making periods for the students and you mentioned segregating the decision periods and having a separate one for men and women students. I'd like to give you an example of how I would feel in that place. I go to MIT, and if they said, "All right, the women will worry about their decisions the first week of October and the men don't have to worry about them until the last week of October," I'd say "Wait a minute. Are they implying that I don't have the competence to make my decision at a later date when the men can put it off until then or what?" Just by segregation I would feel the implication of a second-class status. I would be very much hurt by being segregated from the male classmates in engineering.

Bob Gardner: If you're a faculty advisor and you have a mixture of males and females with a two-week period in which they're supposed to make course decisions, you may find that the females come in before the males. Now I think you will also find that females do not come in at the last minute, and, therefore, if you set up appointments you can avoid a lot of frustration by taking the females first. That's the kind of thing I mean being that there are different patterns. I'm not suggesting that you set up different calendars.

Mildred Dresselhaus: I wanted to add a comforting note to Esther's study. My observation is that about the first ten years out of Ph.D., it was more difficult for me to get ahead than men, but after the first ten years, it was easier. Maybe that's the general phenomenon. Maybe it points out the idea that once you get beyond a certain level, your sex is absolutely no obstacle. And you're much more visible and that makes it an advantage.

John Parrish: Let me just add one or two more comments. In the replies

that we received from the Cornell-University of Illinois graduates, we got replies like this: "As for the possibilities of combining engineering with other career options, my counseling can only be described as non-existent. I did learn of some of the options, but only by chance." Well that's very difficult to interpret isn't it? The counseling advice might have been there, they just never utilized it. Or it may not have been there at that time, three or four or five years ago, and it's here now. So this problem may have more or less reduced itself.

Unless I misread the signs, and I may, engineering for women is going to expand in terms of the fact that it is versatile and a gateway to more and more jobs. The reason I say that is because of the increasingly favorable attitude by management concerning women engineers when management is under pressure from Affirmative Action programs. If you're going to hire somebody, what kind of a woman do you hire for this, that and the other job? And I think it's rather evident from our own experience that engineering is looked on with increasing favor, so that the options are likely to increase in the future instead of decrease.

Ann Stenbeck: At Michigan, we have formally acknowledged the versatility of an engineering degree by offering an interdisciplinary Bachelor of Science in Engineering degree. It is a recognition that engineering is a good preparation for various graduate studies. In the degree program, people major in pre-law, pre-med, pre-business, pre-dental, or in pre-biology graduate studies and in several other areas. This degree recognizes that the engineering training that you get gives you a good discipline and a methodology and a problem-solving approach. Yet you have the breadth to fulfill whatever prerequisites you have for the graduate programs you're interested in. That has proven to be a very popular degree.

*****

SESSION VI: Women Graduate Students in Engineering

Panelists' Comments

Helen O'Bannon: I'll sketch out some of the issues and problems that graduate women confront, some of the ways in which we can help, and some of the structures and systems we can help build to solve some of these problems. Our panelists are Irene Peden, Aghavni Bedrossian, who is a graduate student in Chemical Engineering at Columbia University, and Paula Stone, who is a graduate student in Civil Engineering at MIT.

Women in engineering who are at the graduate level have high aspirations, and come in with normally high records of academic achievement. We heard today that in the Cornell data there is some indication that women have considered graduate work quite early in their decision-making process. So this is not a new idea; it is something that has been formed and thought about for awhile. We don't have any clear data on the actual decision to go to graduate school. What we want to look at in this discussion is the decision to go to graduate school, who reinforces that decision as an alternative to going into the work world or to other kinds of professional education, what are the alternatives, what are the concerns that women who are thinking about graduate school in engineering have to consider? And where do they go for advice? What kinds of advice do we give? What kinds of advice do their peers give? What kinds of advice to their families give? How can we help reinforce this decision?

Another area we would like to address is the area of financial support for women entering graduate programs in engineering. It's the issue of stipends and tuition assistance, the role that women can play as teaching assistants, and any problems that may be unique to women who attempt to become teaching assistants as part of their engineering graduate program. What about their role as research assistants? We probably also should look at the issue of women who would like to return and do graduate work, but who only want to do it on a part time basis and do not have assistance from corporate employers because they have been out of the work force for one reason or another. What are university policies regarding assistance to part time students? Can we change these policies? Should we change these policies? What are the implications of doing so?

We also probably should look at the issue of helping women who come from different disciplines obtain financial support. It seems to me that engineering as a graduate program often attracts men and women from different backgrounds, and this may not be a problem unique to women. Individuals come into engineering at the graduate level, not from physics necessarily, but also from math or biology backgrounds, where the heavy engineering theory and science has not been a part of their undergraduate education. They will need to do some remedial work. Who finances this particular first phase? What kinds of efforts should we try to launch in helping them find funding? We mentioned some of the academic problems, conflicts. One is preparation, as I just mentioned, the course work, research projects, the whole area of confidence as a graduate student, when does it wane, what can we do to help students regain their confidence? What is the role of peer support? Of faculty support? How do we help graduate women maintain their momentum and persist to the happy conclusion of a Masters or a Ph.D.? The role of faculty I think is

crucial. We should probably look at the role of faculty separately between male faculty and female faculty, because I think there is probably some distinction. What is the role that the adviser of a graduate woman engineer must play?

And finally, I guess we probably would want to look at some of the personal attitudes that women have who are in engineering, their motivation, the crisis of confidence, the isolation, again, and lastly the sexual conflicts that are potentially present in dealing with faculty and peer in a predominantly male environment.

Irene Peden: I'm not going to present aspects of my years of anecdotal information gathering on all of those points, but there are a few to which I think I would like to address myself. As far as the financing of graduate education for women engineering students is concerned, I see that as a very important aspect of retention of women who are graduate students in engineering. We have heard from several of our speakers already that women engineering students tend to be more concerned than men with the financing of their education and are also less likely to receive parental aid. I would imagine that these things are even more true of graduate students. Possible remedies include more teaching assistant and resident adviser support from departments. For many universities, the research assistant support is an independent faculty principal investigator matter, and I suppose the best that one can do is to hope to transmit to faculty colleagues the importance of making that kind of funding available to women students. Very often it happens, at least in my university, that a person with grant funds husbands them very carefully and may only allocate them to Ph.D. students, and I really don't think that there's very much that we can do to change that nor perhaps that we should. Teaching assistant funds, on the other hand, are typically granted by the department chairmen in consultation with faculty committee people, and I think there is a very good possibility of communicating with faculty about the importance of allocating funds to women and about women's special needs. I have seen at least one department chairman come quite a long way in this regard. There was a time when this department chairman would always slide the name of a woman graduate student in the department who had applied to be a teaching assistant to the top of the waiting list. If it had been suggested by the faculty advisory committee that she be in the selected group in the first place, she always ended up first on the waiting list. We had a few conversations about that over the years and I can say with confidence that in that department in my university as far as I know no woman graduate student who is qualified to be a teaching assistant and who wants to be a teaching assistant is without that kind of support. So people do move and very fine faculty friends and colleagues who are white males are there. We all know that, and in all the remarks that I would make, I want it to be understood that that's granted from the outset. They are there. The women students know who they are. The minority students know who they are too.

It would seem that more fellowships are needed for women graduate students. There are those who do not wish to be and whose best interests would not be served perhaps by being teaching assistants. Sometimes they have interdisciplinary backgrounds and they need a little time to tune up on the particular specialty in which they're planning to do their graduate work and perhaps they would not be qualified to teach in the depart-

ment when they are brand new graduate students. I think those of us who are concerned for women graduate students and for their financial support can try to help that happen just by transmitting the information that it is important. Often it happens that our colleagues who are men of good will simply haven't thought about these matters and one of the things that we can do is to tell them. I would certainly say that when an institution, whether it's an educational institution or an industrial institution, gives money to assist women or minority students in completing their education, that institution has made a very visible commitment to seeing women and/or minorities succeed in engineering. And the message is very clear. If you are a position to solicit funds for this kind of purpose from any source, I think it doesn't hurt to point that out to them.

Helen mentioned the extra uncertainties that can arise for women in getting launched in a research program. Here let me first distinguish between Masters level research and Ph.D. level research. They are different. And I don't think that the launching of an MS research program, in an institution that has a thesis option with their Masters program, is necessarily very traumatic for most people. Often it happens that a faculty person has something on hand to be done that can be given to the student who wants to do Masters research, and it isn't very often the case that we require the student to generate his or her own research project. When it comes to Ph.D. research, it is the case that we would expect the student to evolve something that he or she wants to work on. I would view the faculty adviser's role in that case as simply being one of being sure that the problem is of sufficient interest, that it is workable in some meaningful way within the time limits of a normal graduate student education, and that the student's time will not be wasted.

How about the matter of stepping off into the unknown to do a piece of research? That was an uncomfortable thing for me at an early stage in my Ph.D. career. I have talked with a number of women graduate students through the years who seem to experience this same kind of uncertainty and self-doubt. We have heard from several of our previous speakers that women seem to experience lower aspiration levels, lack of confidence, fear of losing their femininity, and fear of failure. That fear is particularly acute in the face of the unusually high visibility that they have in their graduate student environments in engineering. And all of these factors coalesce to make the experience of launching their research even more anxiety-producing than is the case for men. And it certainly is anxiety-producing for male students too or can be. It's terribly important, I think, that when those periods come along for students, moral support be available from the faculty supervisor, from other graduate students, particularly from women if there are any in the environment, and particularly from women faculty. To the best of my knowledge, I'm quite sure that we have never had a woman graduate student in the Electrical Engineering Department at my university who didn't find it terribly important to establish a personal relationship with me, to get acquainted, to be able to come in and talk about anything at any time, and so forth, and to really make use of that relationship during the difficult periods. It simply has never happened otherwise. With undergraduates, some yes, some no. Some of them need us, some of them are pretty self-sufficient.

I also have noted in talking with women graduate students that they sometimes feel that they are not taken seriously, by other students or sometimes even by the faculty. Sometimes their motivations for doing their graduate work even seem to come under question, which makes them feel very distressed indeed. It's particularly difficult in the dry periods when nothing is working and, God knows, we all have those periods. It's a question of being able to transmit to them that "Yes, it's happened to all of us and it will come out all right." It increases their sense of isolation. I did some work several years ago with a developmental psychologist at the University of Washington. It was a study that was related to women engineers in various kinds of ways. And, in the course of that work, the psychologist said to me that she had come to believe that the commitment that a woman graduate student makes when she is doing her undergraduate work in an engineering field is as great as a commitment as a medical student would have. So it's particularly difficult, if that is true, for a woman student with that level of commitment to find her motivations questioned by people around her. And I believe that women faculty and male faculty can be very helpful in that connection.

When it comes to the personal, sexual pressures in the environment that Helen mentioned, I have picked up the fact in conversation, that rather few, but not zero women graduate students at my place do feel vulnerable to this kind of pressuring from some members of the faculty. And it's a double-bind when it happens. She is in a position of being damned if she does and damned if she doesn't, or feeling at least that that's the case. One wonders sometimes whether such men really comprehend the degree of power that they appear to these young women to have over them. Whether they do or whether they don't, putting it in that perspective, it is a serious misuse of power. And apparently it does happen. We had a small committee come to a campus-wide group of faculty women several years ago at my university, to present this as a problem that they believed the faculty women should do something about, should try to help them with. And we found ourselves in a "What can we say or do?" kind of situation. One of the solutions that was proposed we sidetracked as best we could and it never came off. The president of the graduate and professional student senate, a young man who was concerned about the problem too, offered to do an informal survey and publish a list of offenders. And we said "Oh my God. The possibilities for error and damage with that kind of hearsay evidence are too great." Fortunately, it never happened. In talking with women students about that issue, which has happened rarely in my career but has happened, it was not in advance of the fact, it was after the fact, and what can you say except to give what reassurance and care that you can?

I think that role models are terribly important to retention of women students at all levels. We have all acknowledged that in all kinds of ways in our time together here. Role models can be women engineers who have made it through graduate school and who are in the working community. They can be members of the Society of Women Engineers and contact can be made with them through that organization if you have no women graduate students or post-graduate students on your faculty. They don't even have to be physically present sometimes. I didn't have any when I went through graduate school at Stanford. I was the only woman. I did find out some years later that after I finished at Stanford a young woman at Berkeley who was going through all by herself had heard about me

somehow, although we had not met. We are now very close friends because she's the junior woman in my electrical engineering department. She told me when we first met that when she was going through graduate school at Berkeley, she had heard about me and during those difficult, dry periods she would say to herself, "I know that Irene made it, and therefore I can make it too." So they don't have to be there, but it helps.

There is a visible advantage to having printed materials available on successful women in engineering. The Society of Women Engineers and John Parrish have been very much involved in that and the proceedings of this conference will be involved in that too. Faculty women who are present I think are perhaps the closest and most supportive role models that women graduate students can have. We're there, we understand it all, we've been through it all, and we care. And there can be no question in the minds of women graduate students that we care. I have been the only woman faculty member for some years, and I'm pleased to report that at the University of Washington this past year we had three women faculty and next fall we will have five. These are all regular tenured faculty appointments. We also have one woman in a research position in one of the departments. So I'm sure (my role) is going to be diluted, and although I'll miss them, the number of women students is escalating too, so I guess things average out. And again, I want to emphasize that there are always sympathetic and helpful male faculty in the departments when they are needed to talk things over, and that the women students know that. I have noticed that graduate students, at least at the University of Washington, are very interested in the status of faculty women. They keep in touch with us about it, and when there are studies made on campus about the status of faculty women, they want to know about those studies, they want to know the outcome, they want to know the salary, promotion, tenure situation and all of this. I believe that they simply use this information as reference data in order to see how they are doing and what their potential is going to be. So I think that faculty women are very important to them and are a very big factor in their wanting to stay in the engineering field and to complete their graduate studies.

I wanted to make a comment about something that came up last night that bothered me a little bit because whereas it may be representative of other universities, it's not representative of mine and it very clearly was not representative of Purdue. It was suggested that sometimes women graduate students are given back-burner kinds of research projects to work on because they are women. That really caused me to sit up straight in my chair, because I can't think of anything more counterproductive for everybody than that, and I can't imagine that happening at the University of Washington. I can imagine that it could happen in a situation where a faculty individual has more graduate students than he or she can handle, although I have not heard of a woman faculty individual in engineering having more graduate students than she can handle. But in any other context that I know, I simply cannot imagine such a thing happening, and if you know of any students through the grapevine who feel that that has happened to them, send them to us. Gee we'd like to have them.

I also wanted to discuss the matter of how decisions are made about doors that will be opened for graduate students and doors that will remain closed. In the context of women graduate students, it could involve faculty decisions about whether it's go or no-go on admission to the

Ph.D. program. There are other kinds of situations in which individuals are judged and doors are either opened or kept closed that are not related to women graduate students particularly, but can be related to professional women in general. I've seen a few of those since I've gone into administration. I think it's something that is not always realized unless you sit on those kinds of judging committees or judging faculty bodies, and that is simply the fact that very subjective decisions are very often made in the final analysis. When you get down to the end, and there are a few candidates left for some kind of honor, whether it's admission to the Ph.D. program, a faculty offer, or administrative internship program, or what have you, they're very subjective judgements. Typically the last remaining contenders are all excellent people and they would all do very well. The final decisions are not usually made on factors of purely technical, professional excellence. I have seen it happen more than once, in a case where a woman candidate was highly recommended by some and not highly recommended by others, that men who would have recommended her highly did not feel comfortable defending her when opposition to her candidacy arose from other men. They find that very difficult to do. And I am sure, although I can't prove it, that there have been situations in which the fact that I was there on the committee or in the room was a factor in an eventual "go" decision, instead of "no-go" when a woman candidate was controversial. I don't know what we can do about that except that we can tell our students when we need to that this is the case, and ask them to recognize that it is the case, and just be aware of how decisions are made.

Aghavni Bedrossian: The information that I could tell you is very limited, because it is based on my personal experience as a graduate student and doctoral candidate at Columbia University, and also the experience of the very few female graduate students at Columbia University. Please keep that in mind in regard to the comments that I'm going to make.

First, I would like to make a comment on the financial support provided to women graduate students. In Columbia University, all the women who have been accepted in the graduate program have received financial support, either as teaching assistants or as graduate research associates, depending on the amount of involvement they would like to get. For example, some of us are interested in teaching, and being a teaching assistant gives us a good opportunity to get a first hand experience. And some of us would like to concentrate on our research work right from the beginning, and becoming a research associate makes it much easier to continue the Masters or the Ph.D. project. Another source of financial support which I think many women are not aware of is the American Association of University Women, the Fellowship Office, which is located in Washington, D.C. They give about eighty to ninety fellowships a year to women in the doctoral program, depending on scholastic achievements. I think this should be kept in mind and should be advertised in engineering departments.

As far as people entering the department with different backgrounds is concerned, at Columbia there is a special program which is called the Four-Two Program, in which a person with any kind of a background could come in with a B.A. or a B.S. degree and enter an engineering field. After two years, they'd receive a Master of Science in their particular engineering field. Of course, it is a very difficult program, the load is very great, and they have to take undergraduate and graduate courses at the same time, plus complete a Masters project. However, all the

people who have gone through that program have been greatly satisfied with it. Also they've been provided with financial support from the department, most of the time in the form of research assistantship because they would not know enough in their field to be able to teach.

I would like to comment on decision-making for going to graduate school. As far as I'm concerned the decision for going to graduate school came after I worked for industry for three months. I realized that the type of work in which I would like to get involved requires more knowledge and more qualifications than my B.S. degree has provided me. This gave me the stimulus to go back to school and continue for a Masters degree. Of course, I consulted with some of my colleagues at work and with my professor. Most of all, I am thankful to Professor Mary Anne Farrell, who was extremely helpful. She has given me the greatest motive to go on for a Masters and eventually a Ph.D. degree.

I must say that the faculty at Columbia University has been extremely helpful. They've always been there when we needed them to consult with us and give us some advice for going for degrees. For instance, they encourage people who are going for a Masters or an M.B.A. However, they discourage one from going through the Ph.D. program if the person is more practically inclined, for the simple reason that with the Ph.D. degree you would tend to go more into research than into the practical aspects of production.

Irene made a comment about the uncertainty one can feel when you're faced with a project in the Masters level and Ph.D. level. I would like to say that this type of problem could be solved if women are introduced to projects much earlier in their studies, for instance in their junior and senior years. I'm talking about a completely independent project which has nothing to do with the usual laboratory course. For instance, at our department we have an undergraduate research project in which the student himself chooses the topic by consulting with professors to see what is available. Of course, there are only one or two people doing that out of a class of forty or forty-five. But I was one of them, and I found that afterward when I started my Masters research I did not have as many problems. I knew how to approach it and exactly what I was looking for, how to build the system. Everything was much more accelerated and I got the results faster than in the senior project. So I think it is a better idea if students in general, not only women but all students in engineering, are introduced to individual projects in their undergraduate years. It also is good if they're asked to write a small report in the form of a technical paper because this is very helpful when the time comes to write a Masters or a Doctoral thesis.

Another thing is the communication among women graduate students. In our university, we are very few. There are only seven or eight of us in the graduate school, and there is mostly an atmosphere of seclusion and separation from one another. We don't tend to cling together and work together. On the contrary, since we are dispersed in the different fields of engineering and there is only one of us in a field, I guess each one of us feels like queen of her own show and they don't want anybody else getting into it. So there is very little communication. Even though I've tried very hard to get together and organize things, they have refused to, mostly on the basis that they enjoy being the one and only. Of course, another factor has been the hard work that one is required to put in while pursuing these studies.

Another comment I would like to make is on the confidence of women. I must admit quite honestly that I did not have confidence in my work or in my accomplishments until the end of my senior year when there was a chemical engineers contest in the New York-New Jersey area, and I was working on a senior research project. When I saw the advertisement for the contest, I decided to enter it. After winning the first prize of the contest, I realized that I am capable of working and performing just as well as anybody else. So this was the time that I gained some confidence. But the confidence was even further reinforced after passing the necessary exams, which we call qualifying exams, for the doctoral program. Since only 50% of the candidates passed and I was among that 50%, then my confidence was regained completely. I think it is very important, especially for a woman engineer, to have her achievements written in black and white, which will give her confidence.

I would like to comment on the support from peers and the faculty. There are two types of interactions between peers and the woman engineer. One of the interactions occurs when your friends or your classmates are self-confident and they know that there is no competition between you and them. Then you can have their complete support. They try to help you in any way possible in physical matters because especially in chemical engineering the laboratory work involves moving very heavy equipment or barrels of alcohol or ice cubes or water. They try to assist you as much as they can. However, the group of people who are not as confident in their knowledge or capabilities as the others tries to diminish your achievements in many different ways, either by subtle remarks, or gossip, or very bitter jokes. And the advice I could give to women who are put in that position is to not pay any attention to them. It is just their jealousy, that is all, and they are not mature enough to handle it any other way.

As far as faculty support is concerned, I think at Columbia University there has been no discrimination whatsoever between women and men. We have been treated equally and very well too. Whenever students have needed support, the support has been there, especially if the faculty member is female. For instance Professor Mary Anne Farrell has been very helpful toward women engineers. She's always been there to give us advice and to give us her moral support and encouragement.

I would like to say a few words about the feminine motive to avoid success. I think that this is not a problem with most of the women. On the contrary, since there is so much talk about women being the more submissive, the weaker, and the less knowledgeable, a woman is more determined to show them that she can be even more successful than they are. At least that has been the case with me. Of course it has presented some personal conflicts and problems, but I think that in general women would like to succeed and show them that they have done it too, rather than avoid success.

In closing, I would like to say to women engineers that there are difficult moments, there is a lot of hardship, but it is challenging and it is very interesting, and never give it up.

Paula Stone: There are really very few additional comments I could make to the experiences at Columbia. I think in many respects graduate student women face some of the same problems that undergraduate women do in the sense of being attracted into graduate school and also finding sup-

port for their activities once they're there. Of course, I'm basing my comments on my own personal experience as well as the women graduate students that I know now. But I think it's interesting when I look at the graduate students that most of them are Masters candidates. Most of them did not come in for their Masters degree until they'd been out working for a few years and realized the need for more education. I don't think that's any different than their male counterparts, but why they aren't attracted into Ph.D. programs is something that I'm somewhat puzzled about. In my division right now I'm the only woman working on her Ph.D. I find that the other women who have come to talk to me about that have basically not thought about the opportunities that were available to them by going on for the Ph.D. They've often asked me what some of the issues are that I've thought about in making that decision. They haven't been exposed, I think, to the opportunities that might be available, and I think basically have some qualms about it. It has an awesome connotation to it, and I think there's an initial trepidation that might simply be dispelled by publicizing opportunities, by having more discussions. Of course we're in a small group at the moment and we get to see each other so that we can air some of our feelings. The department in general is very scattered. I'm specifically in the Waters Resource group, and at the moment there are probably about seven graduate student women. The rest of the department has women scattered all about, I'm not sure how many there are, I haven't seen most of them. And I think that a problem with graduate student women in general is this feeling of isolation, of not seeing each other, of being very much involved in their own situation. Some of the departments at MIT have set up informal structures for allowing the graduate student women to meet each other. My department hasn't done that yet, and I'm not sure what the need is. As I said, in my particular group we do see each other and discuss these things.

This brings me into the whole question of support structures. Besides just meeting other women, I think that there is certainly a need for faculty support. I've been particularly lucky, and I think it's probably true for my department as a whole, in that the faculty has been very supportive of me and very encouraging. I certainly haven't heard of women being stuck with projects that they haven't been interested in. I have heard of cases in other departments from female students who have talked about not feeling that their adviser was taking them seriously. They haven't felt comfortable in talking to their adviser. One of them in particular was able to switch her thesis supervisor. This isn't always possible. Sometimes girls don't feel aggressive enough to be able to do that.

I think confidence is an interesting issue to look at in terms of the women I know in graduate school as being very highly motivated. I think where the difference comes in is in aggressiveness. The women I know tend to be either so aggressive that probably nothing could stop them, or very timid, though not any less dedicated to their work. How one deals with this is certainly perplexing. I know of a girl who had initially talked to her thesis supervisor about her work and had questions about it, but for some reason just didn't clarify them with him. She ended up, essentially, wasting four months on her research until she finally was so frustrated that she went and talked to him and they got the points clarified. I think too, when we get into the dry periods when research isn't going well, when nothing seems to be working, that

that happens with males as well. The interesting thing though is that the type of syndrome women I know get into is not so much to think, "Well, it's a bad period and I'll take a few days off and come back next week and everything will be fine," but rather they start questioning their whole presence in research, whether this is the right thing, "Am I justified being here at all?" It gets into a very personal traumatic type of identity crisis, and I've seen this periodically happen to several women. Rather than taking it out on their research, they end up internalizing it and taking it out on themselves.

In terms of financing, my department guarantees any entering graduate student financial support, whether that be as a teaching assistant, research assistant, or sometimes an institute fellowship. Of course, students can come in with their own funding. Students state a preference for the type of option that they want, and usually they're fulfilled, I don't know of cases where they're not. Included within this is the type of research which they'd like to work on, if they choose to be research assistants. I'm not sure how flexible it is to move around, but most people that I know who are working in research have ended up on those projects which will become focal points for their own research in areas that they themselves are interested in. We talked before about the need for some type of exposure to the research experience before graduate school. MIT does have a program called the UROP program, Undergraduate Research Opportunities, which does give undergraduate students a chance to work with industries in the area. This, of course, is one mechanism. I think, as I alluded to yesterday, there is also a need (to help) women who aren't confident in working with other people particularly, who haven't had that much exposure to situations where they've had to get in front of a classroom situation, where they would have to defend their ideas. I think that's also an important experience for males as well as females at the undergraduate level.

Session VI: Questions and Answers

Athena Theodore: Do graduate engineering students consider academic careers at all?

Paula Stone: Well, I do and I don't. Personally I haven't decided yet. I can think of two other women graduate students working on their Ph.D.'s and both of them are considering industry. I don't know why that is. I think for myself part of the problem is that I haven't had exposure to the teaching experience yet, and I hope to make time for that before I leave the Institute. But I'm not really sure what that experience is like. I think I'd face it with a little bit of fear and then maybe when I'm in front of a class, that it wouldn't bother me. As for the other two people that I'm thinking of in particular, neither of them has had teaching experience. Both of them have worked on individual projects throughout their Ph.D. research. I think maybe it's this lack of interaction with people that may be one cause of their not thinking about a situation which will put them more in contact with other people.

Lilli Hornig: I wanted to comment on a couple of things Irene said. She mentioned that there are many ways to open and close doors, many ways of selecting and not selecting people for specific honors, fellowships,

positions, what have you. We have noted a phenomenon in our files, which I didn't want to believe at first. I had read an article in the Modern Languages Journal on male chauvinist pig recommendation letters, with a lot of quotes, and I began to think that this just wasn't so. We didn't see many of those when we started three years ago, but as the years have gone by, we have opened up what we call the male chauvinist pig file, and it has a great many documents in it. Several come to mind. One was written by one of this country's outstanding physical chemists who is now retired and was for many years on the Harvard faculty. He was writing me about a woman student of his whom he described in his personal letter to me as one of the three or four best of the over one hundred graduate students, who are obviously the pick of the country, whom he had taught in his lifetime. In the reference letter that went into her dossier at Harvard, however, he stated clearly and in so many words that he felt there was really no place for women in science, and while she was competent, she lacked imagination, motivation, drive, all the rest of it. I wrote back to him about this for clarification and he said it seemed quite obvious to him that women really were not suited to be scientists, and the fact that she'd done so well as a student he found a little hard to explain, but he really could not recommend her for a major faculty post. We have another letter in the area of languages from an instructor of Italian. The letter is about a young woman student whom he describes in quite glowing terms throughout the letter. The last paragraph is, "In short, she is very bright, very beautiful, and very sexy. Her French (doubly underlined), is outstanding." If I thought longer, I could come up with a few more such examples. I think we have to be very careful about those doors that open or don't open at the right moment.

We have looked very hard for evidence of discrimination in the award of scholarships and fellowships, and have found none recently. I think there's been a good deal of it in the past. But as near as we can tell, in the past three or four years, there has not been that kind of discrimination. I think we're still going to see some certainly in the academic job market. Industry is handling this very differently. As I was talking with some of the people here today from industry, they've built incentives in for individual managers to fulfill their Affirmative Action quotas, so to speak. That's a dirty word in academia. You don't do that. You also don't order the faculty to do anything, and that's one reason why Affirmative Action hasn't been terribly successful. There was one suggestion made about fellowships or scholarships specifically designated for women. I doubt that that will hold up under Title IX, I doubt it very much. I think most institutions which have either merged or gone coed are working very hard with their lawyers to determine just how to get around the provisions of wills that left money either for male or female scholarships. I think that is one area that we ought to just forget about.

Irene Peden: Let me say in response that we do have at my university some funds, the total amount changes from time to time, which have been given to us by various industrial friends. Usually because they want to hire women engineers, they want to do what they can to get them through the system and out so that they can be hired. There are no games being played about that. But they will give money and say, "Why don't you allocate this at a tuition level (or something else that they can specify) to women students or minority students?" Again they may specify. If they want to leave it open, we'll allocate it on an open basis and a

committee will decide where the scholarship money will go. If the company wants to put strings on it and say, "We'd like this money to go only to senior women in Chemical Engineering and Mechanical Engineering" (and I've just made that up), then fine, we'll allocate it that way. Now these are not large sums of money. They're tuition level, with sometimes something left over for books. And it's fairly informal, it's between them and us, the College of Engineering. But these kinds of funds are available, and I think they do a lot of good for women students. Sometimes we can give them to graduate students unless we're told they're only for seniors. I hope we don't have to give that up, because I think that is extremely valuable, and gives a lot of visibility to the commitment of those companies.

Dena Skalka: Another kind of thing that industry can do is to grant a fellowship to a specific woman, and then let her go to the university of her choice. This, in effect, encourages outstanding women and may get around Title IX problems.

Helen O'Bannon: Yes, I think if the money is given to the individual, there's no argument at this moment anyway. Things change rapidly.

Athena Theodore: Just a trick of the trade. One way of finding out what is in your dossier is to ask a sympathetic professor to send for it. I have encouraged people who have not been able to get jobs to do this, and we're learning. We do find in these dossiers many, many remarks which might be excluded. Women do happen to have pleasant personalities, and they're sweet, and there's an awful lot of that stuff that goes through that is not really intended to be in any way sexist, but there it is. It is possible to get these things corrected. Students now also can get to see these dossiers. In most places I guess there's still some resistance, but they are entitled to do it. We are getting somewhere with those, and they are terribly important. If you ever have doubts as a graduate student about what is in your files, there are ways of finding out what's in them.

Mildred Dresselhaus: I would like to underscore the importance of two things. One is undergraduate research. I think that we should get women engineering students in the lab in a research situation as soon as possible. Even if the project itself isn't of great significance, the experience of being in a lab and understanding what some of the socialization issues are is very important, so that when the time comes to do serious research they're emotionally ready for it. The other thing I'd like to underscore that is very important is that all women engineering graduate students see to it that they get an opportunity to teach, whether or not they're interested in academic positions. For one thing, you never know what's going to happen in your own career. I never thought in a million years I would be a professor anywhere when I was just completing my Ph.D. The teaching experience is very valuable. Sometimes the only chance you have to get it is when you're in graduate school. But even far beyond that, every person in professional life has to give many talks, and there is no preparation for professional talks like teaching. And since women are so visible at the professional societies, getting some experience before you have to give your first one is really fantastic. I'd encourage you all to do that.

Helen O'Bannon: I think also this feeds back to this morning's comment that it's important for men as well as for women to see women in the classroom handling technical areas with experience and expertise and familiarity and confidence, and I think this exposure is what we all need to change our conceptions about what women can do and do very well.

Tucker McHugh: You spoke about institutionalizing support, and that reached me because of what you described as the separation of graduate students generally. I don't think this is specific to engineering nor to women, but just that the structure of many graduate schools tends to isolate students from one another. I don't (counsel) many graduate students, and I've never seen one professionally in engineering, but I do find that the graduate students that I see tend to come at two points. The majority of them are about to take their qualifying exams or about to take their A exams. This is just a tremendously destructive kind of pressure for a lot of people. If support is to be institutionalized, it seems to me that those are the very critical points to begin with, not just for women and not just in sciences, but right across disciplines.

Helen O'Bannon: I had a friend who was taking her qualifiers about three weeks ago. She was in her late thirties, and she had one of these crises of confidence. She happened to be going away on a holiday afterwards and the woman in the couple which was joining her was a psychiatrist with the University of Pittsburgh's Health Service, happily I think. And my friend said to her, "Do you ever see people right before they're taking their qualifier sort of in the basket like I was?" And she said, "In all my experience, twelve years, no one has come in before, but I can't tell you how many come in after."

Tucker McHugh: I see them before and not after. It's particularly destructive to the older graduate student, and especially for the woman who has children at home, because she not only feels guilty about what she's going through, but also about what she's putting her kids through.

Irene Peden: I've seen them both before and after, and I've also been called into sudden emergency service just before a dissertation defense. "Please come in, just sit there, just be there," and of course I do that. Sometimes the faculty research supervisor will ask me to be on the committee in the first place. But in the cases where he hasn't, I've rushed in with Band-Aids and love to sit there and just listen to something I didn't even understand because it was important, a crisis of some kind.

Helen O'Bannon: I think we all have them, men and women, and if we can all help each other, that's important. We all have to be aware of these vulnerable periods that graduate students go through.

Carol Hall: The comment about having a crisis after your exam really hit home because I know Tom and I went through a real dip right after our exams for about six months. And I talked to a number of people at the school where we did graduate studies and it turns out that this is a standard phenomenon. Most people after they get their Ph.D. go into a real depression. Psychosomatic illnesses have been noted and occasional suicides during this time. After they've finally succeeded, they've finally made it, now what do they do? I don't know if I can

explain it, but it really is a phenomenon that might be looked into.

Helen O'Bannon: Well, I've seen it among undergraduates, particularly in the liberal arts, who are finally getting their B.A., and then what do they do?

Tucker McHugh: It's called the "senior syndrome."

Helen O'Bannon: That's right. I guess I'd like to say a couple of things, since I merely got a chance to introduce the topic today. I think we who have the position or responsibility of helping women who come in as graduate students, and men for that matter, must evaluate them as individuals when giving out financial aid. It has come to my attention that women frequently don't have the opportunity for aid because of university regulations if they only want to go three-quarters time due to home commitments. I think somehow the network must be able to appreciate this individual's desire, demand, and need for financial help of some kind, and evaluate her commitment on the basis of her as an individual and her desire and ability to succeed. I hate to see the inflexibility of any institution deny the eager, able person this opportunity.

I also think that we could all do more to draw graduate students together, particularly the women students. One of the fun things I do at Carnegie-Mellon is to throw a wine and cheese party for all graduate women on campus; there are about one hundred eighty. And maybe we get forty-five. We get Masters of Fine Arts, the painters, musicians, the engineers, the computer scientists. It's one of these marvelous kinds of parties where everybody sits around on the floor, and they make very good friends and go off and have lunch frequently in the course of the year, computer scientists with the artists, etcetera. Wine and cheese make strange bedfellows, even among graduate women. But I think there's a feeling of support from just the mere knowledge that there are other women on campus in graduate school,a sense that "My Gosh, there are other people out there."

The other thing that's been called to my attention is that frequently our requirements for graduate work, particularly at the Masters level, are not always that clear, and that a woman coming in or a man coming in with a slightly different background, attempting to carve a slightly different path, may not be given good, clear, hard information about when things have to be done, what kinds of core requirements there are if there are any, and what the expectations are in terms of time. If a program says you'll take a series of courses and a thesis will be required, it should be spelled out that the normal student takes twelve to fifteen months to complete this program. I also think for the Ph.D. students we do need to build in some kind of a checking system with a committee meeting to help that person be sure that the dissertation is going well at various points.

The last thing I want to mention concerns sexual vulnerability. I think the woman student is usually the one, regardless of what role she's played, who loses. She frequently is the victim, although sometimes she's the victimizer, but she always is going to get the short end of it. It never works to her advantage, in terms of her career or in terms of her own personal life. I think the thing we should advise is

"Be careful. It's a potential area of danger, stay clear of it. Don't sleep where you work." Little homilies from Helen O'Bannon.

*****

"Women: The New Engineers"

Robert E. Gardner

Last week I scanned a paper on the Engineering and Public Affairs Program at CMU which began:

> "It is becoming widely recognized among engineering educators across the country that realistic solutions to complex societal problems, such as energy utilization, urban transportation, and environmental pollution will demand the professional contribution of a "new breed" of engineer who is both technically competent and also skilled at dealing with the social, economic, and political factors that interact strongly with purely technological considerations. In recognition of this fact, an increasing number of colleges and universities in the United States are beginning to implement new programs, activities, and courses that attempt to provide the broader, more societally oriented perspectives or technology that largely have been lacking in engineering curricula to date.[1]

Who will become these "new engineers?" And who will populate the new interdisciplinary program of study? I believe those females now entering engineering will become a significant portion of the "new engineers" because these females possess the necessary broad intellectual interests, psychological attitudes, social concerns and personal values required for this new role. Neither entering males nor practicing professionals exhibit these traits to as great a degree.[2]

Our knowledge of those practicing the profession--almost exclusively male--is extensive.[3] In addition to statistics reporting salaries, responsibilities, and similar data, there exists considerable information about the personal characteristics of engineers, about their attitudes toward work, about their cognitive styles, about their personal psychological profiles, about what sociologists call their norms as a group. Engineers are described as work oriented, "are most at home and most competent when (their) work is clearly outlined," and "tend to limit their attention to immediate matters, and not to things far beyond the next step."[4] Their mental habits are characterized by a lack of imagination, minimal creativity, and a distaste for intellectual freewheeling or brainstorming. They prefer objects and processes to people, are impersonal and defer intimacy, control their emotions well and behave in an authoritarian way. Matter-of-fact and objective, direct and straightforward, they are not given to introspection. They like, seek and successfully maintain structure in their lives.[5] They hardly resemble a group well suited to be the "new breed" described above.

We also know a considerable amount about engineering students--again almost exlusively male--and that they resemble those practicing the profession. Engineering students have a strong career orientation and a pragmatic style, they are "modest in (their) aspirations, narrowly trained, active rather than contemplative, intolerant of ambiguity, and approach engineering as a job rather than a calling."[6] They value task

completion more than task initiation. They usually exhibit strong authoritarian behavior, they have lower than average aesthetic and cultural interests, they are less interested in other students than most students. National norms reveal that in comparison to peers they are considerably less interested in the performing arts, in helping others in difficulty, in participating in organizations like the Peace Corp, in writing original works, or in creating artistic work; they are more interested than most students in being well-off financially and in making a theoretical contribution to science.[7] Again, as a group, they do not exhibit the characteristics one might look for in a "new breed."

In comparison to the above, our knowledge about women in engineering is meagre. At Cornell, we discovered that women see engineering as an intellectual challenge rather than a means for a financially renumerative career, that they consider helping others a very strong component of a career, that they are not as interested in the managerial or authoritarian behavior aspects of the profession.[8] They are much more well developed in an aesthetic and cultural sense, displaying greater interest in art, drama, music, novels and poems, and in the general intellectual milieu. Their expectations for social involvements with other students is significantly higher than for males, and their patterns of social involvement in secondary school are broader and wider-ranging.

Based on this research, it seems reasonably clear that these females represent a new breed--if not the new breed--of engineers.[9]

That is the bright side--the genuine prospect of the so-called new engineer and the prospect that women will be leaders in this profession. But there is also a dark side, a side too often forgotten in the success we have recently enjoyed in recruiting females in record numbers. The dark side is the information we have about students who do not remain in engineering, which is about half of those selecting engineering as a freshman. As a group, these students show less stereotyped thinking, have greater social awareness, have less need for external structure, feel more at ease with complex issues, and tend to exhibit an intellectual rather than a practical orientation.[10]

Engin Holmstrom reports that:

> Students defecting from engineering have been described as less stereotyped in their thinking than "stables", as having more need for social activities, for conversation with the opposite sex, and for autonomy; as being more intensely involved with other people, more introspective and self-examining, and having a broader and more humanistic set of interests and values; and being more tolerant of ambiguity and originality.[11]

When these characteristics are compared to those of females, the similarity is immediately evident. This suggests that as a group females may not become the new engineers, rather they may swell the ranks of those leaving engineering.

My experience with females transferring out of engineering at Cornell has convinced me that women experience difficulty in engineering because they embrace values that are foreign to an educational institution and a profession that has "masculine" norms. In 1967, S.S. Robin

reported these findings:

> It appears that the female student engineering role, in addition to being demonstrably different from the male role, involves more tolerance of ambiguity both in professional and relational spheres. There is a discernible emphasis on liberal arts and "intellectual" expectations in the female role that is largely excluded from the male role. . .
>
> The nature of these differences makes feasible the tentative conclusion that the females who do elect engineering as an occupation include general feminine norms into the student role and expect to function with them in the role of engineer. p.213 [12]

Robin's institutional research at Purdue (in conjunction with the Society of Women Engineers) uncovered many of the same characteristics for females that we discovered in our survey here at Cornell; he also correlated these to diminished performance in the engineering curriculum.[13] Moreover, because females seemed to embrace these values as a group he concluded there was no indication women would ever become a significant source of engineering manpower.[14]

Additional evidence is available in the work of Sandra Davis, who studied the persistence of women in science and engineering.[15] Though her sample size was small, she found that at the Institute of Technology (University of Minnesota), only one of every 3 women persisted, compared to one of every 2 men. Within the engineering subsample, which was considerably smaller yet, she found that 30% of the women persisted, 40% of the men. According to Davis, the women in this sample contradict the stereotypes of women in science and engineering. "The women in this study are not 'masculine' or narrow in outlook. They do not avoid social relationships, reject marriage and parenthood, or drop out of technical schools to get married. They do have broad interests; they plan on combining marriage, family and career responsibilities into their life plans; they value social relacionships as much as any group of college women."[16] In short, they are similar to those surveyed by Robin at Purdue and the research group at Cornell.

Davis also found that a number of women withdrew because they felt stifled or restricted by the curriculum, which suggests that the much broader liberal arts style intellectual interest of females entering engineering is an important factor if not a liability--in the persistence of females. According to Davis:

> Given these results, I submit. . . that women entering technical majors not only have but also pursue a broader range of interests than the men. If they perceive that the technical school allows them few outlets for their other interests, then they will most likely withdraw. p. 28.[17]

Since technical institutions are very similar to the environment of the profession in that they reflect the attitudes of the same populations, this raises the question whether we can make the same projections for the engineering profession that we have made for technical institutions.

Table 1 Cornell Matriculants, 1973

Response for ACE questionnaire: "Reasons considered very important for Long-Term Career Choices"

Rank Order

Males		Females	
Intrinsic interest in the field	74%	Intrinsic interest in the field	76%
Work with ideas	62%	Work with ideas	63%
Chance for steady progress	50%	Contribution to society	52%
Contribution to society	45%	Be helpful to others	44%
Be helpful to others	43%	Job openings available	34%
Job openings available	43%	Work with people	28%
High anticipated earnings	40%	Independence	25%
Independence	37%	Rapid advancement	25%
Rapid advancement	37%	Chance for steady progress	25%
Work with people	34%	High anticipated earnings	22%
Respected occupation	25%	Respected occupation	6%
Avoid pressure	10%	Avoid pressure	6%

By category

	Males	Females	
Intrinsic interest in field	74%	76%	2%
Work with ideas	62%	63%	1%
Chance for steady progress	50%	25%	25%
Contribution to society	45%	52%	7%
Be helpful to others	43%	44%	1%
Job openings available	43%	34%	9%
High anticipated earnings	40%	22%	18%
Independence	37%	25%	12%
Rapid advancement	37%	25%	12%
Work with people	34%	28%	6%
Respected occupation	25%	6%	19%
Avoid pressure	10%	6%	4%

In order of magnitude of difference: chance for steady progress
respected occupation
high anticipated earnings
independence
rapid advancement

Table 2 Cornell Matriculants 1974

"As far as you are personally concerned, which one of the requirements below is the most important in any job or profession you would consider going into?"

Rank Order

Males	Females
Opportunity to use my abilities 29%	Opportunity to use my abilities 44%
Prospect of above average income 15%	To be helpful to others and useful to society 37%
Relative freedom from supervision 15%	To work with people rather than things 7%
Stable, secure future 12%	Stable, secure future 5%
Freedom to be creative and original 10%	Avoidance of relatively high-pressure work 5%
Compatibility with colleagues 5%	Compatibility with colleagues 2%
Avoidance of relatively high-pressure work 5%	Prospects of above average income 0%
To be helpful to others and/or useful to society 5%	Relative freedom from supervision 0%
To work with people rather than things 0%	Freedom to be creative and original 0%

By category

	Males	Females	
Opportunity to use my abilities	29%	44%	15%
Prospect of above average income	15%	0%	15%
Relative freedom from supervision	15%	0%	15%
Stable, secure future	12%	5%	7%
Freedom to be creative and original	10%	0%	10%
Compatibility with colleagues	5%	2%	3%
Avoidance of high-pressure work	5%	5%	0%
To be helpful to others and/or useful to society	5%	37%	32%
To work with people rather than things	0%	7%	7%

In order of the magnitude of difference: to be helpful to others and/or useful to society, opportunity to use my abilities, prospect of above average income, relative freedom from supervision, freedom to be creative and original.

Table 3 Cornell matriculants 1973 compared to Engineering graduates 1961 surveyed ten years after graduation**

	I	II	III	IV	V	VI
Chance for originality	57%	50%	--	--	--	--
Can work with ideas	57%	50%	62%	63%	5%	6%
High earnings	53%	50%	40%	22%	13%	31%
Intrinsic interest in the field	51%	50%	74%	76%	23%	25%
Have leadership opportunities	50%	49%	--	--	--	--
Chance for steady progress	49%	34%	50%	25%	1%	24%
Able to work with people	46%	47%	--	--	12%	18%
Rapid career advancement	38%	33%	37%	25%	2%	10%
Enjoyed past experience	36%	41%	--	--	--	--
Provides autonomy	35%	34%	37%	25%	2%	10%
Well respected occupation	35%	27%	25%	6%	10%	29%
Can contribute to society	35%	38%	45%	52%	10%	17%
Can be helpful to others	33%	34%	43%	44%	10%	11%
Job openings available	29%	20%	43%	34%	14%	5%
Can avoid pressure	7%	7%	10%	6%	3%	1%

I Male engineering graduates 1961 (n=1102)

II Female engineering graduates 1961 (n=165)

III Male Cornell matriculants 1973 (n=401)

IV Female Cornell matriculants 1973 (n=34)

V Male engineering graduates compared to male Cornell matriculants

VI Male engineering graduates compared to female Cornell matriculants

** taken from Kaufman

Table I summarized the responses of male and female students entering Cornell in 1973 regarding the reasons they considered important in selecting engineering as a career. The most noticeable differences stem from the disinterest of females in high earnings, in a chance for steady progress, in autonomy, and in rapid career advancement. They also do not select engineering because it is a respected occupation. From this one concludes that females probably will not relate to the superficial reward structure that currently exists for engineers in the profession because they do not highly value those things that are beyond the intellectual content of engineering.[18] If it were not for their intrinsic intellectual interest, the chance to work with ideas and the opportunity to help others, females would have little reason to consider engineering at all. Data from the survey at Cornell for the class entering in 1974 are even more dramatic. Table II presents the response for males and females to the question, "As far as you are personally concerned, which one of the requirements below is the most important in any job or profession you would consider going into?" For females, there were essentially only two responses "opportunities to use my abilities" and "helpful to others/useful to society" with more than one third of the females listing the latter as the most important consideration. In contrast, males reported a spectrum of reasons, including many of the rewards that engineering as a profession has to offer as it is currently structured, and less than 5% responded that "helpful to others" was important. Females are thus much narrower and specific in their motivation as a group, and less attuned to the variety of rewards for engineers. On the basis of these two questions, one can hypothesize that males entering engineering relate to the available reward structure, whereas females related to an entirely different structure--one that may not exist in the profession. If this is true, one can project a conflict for females entering the profession unless their attitudes or the reward structure is altered.

But do males resemble those practicing the profession? That males at Cornell responded closely to practicing engineers in these areas is shown in Table III, which summarizes the results for the same question responded in Table I, but answered by engineers who were graduated in 1961 (i.e. chronologically the group that Robin surveyed) and who responded to the question in 1971, after ten years of practicing the profession.[19] From Robin's work we can assume that the groups entering in 1961 probably closely resembled the groups surveyed at Cornell,[20] implying that in 1961 males differed from females in their reason for selecting engineering. Yet, the 1971 ACE data (Table III) show that the females who remained 10 years in engineering had expectations much closer to those of their peers than the Cornell sample, indicating that entering females who did not share these career expectations either dropped out of the profession or altered their views to fit the reward structure. This suggests that females at Cornell who do not resemble those in Table III will either alter their values or drop out. One thus concludes that females will experience value conflict in the profession--if they survive the value conflict they will experience in educational curriculum.

The problem, then, is this: as a group females possess those characteristics sought for in the "new engineer", but they also possess characteristics that make them more likely to leave the profession. The fact that females may leave in a greater proportion than males is minor,

the major problem is that engineering may lose those it most wishes to retain.

Conflict between values is apparent for a significant portion of the females entering engineering. In the past, the strategy adopted in dealing with the problem was to ignore any incongruence between values embraced by females and those of professionals. Though wasteful, the policy was acceptable because the human displacement was minimized by the exceedingly small number of female engineering students. This laissez-faire policy is no longer prudent, however, because:

1. The absolute number of females entering engineering has risen dramatically. Consequently, the number of persons affected is not negligible, because the magnitude of the loss is sufficient to be noticed by persons outside the profession--particularly those interested in the progress of women.
2. The total number of matriculants at engineering institutions is down, foreshadowing a manpower shortage.[20] Consequently, the relative importance of females is greatly increased because women are a greater percentage of the total. Heavy attrition of females would make an already serious manpower shortage critical. Females have thus become a critical component of the engineering manpower pool, rather than an expendable fringe.
3. Now that females comprise a significant portion of the enrollment at nearly 40 institutions and the economic situation is severe, heavy losses through attrition would be a serious economic matter for these institutions.
4. The percentage of females with feminine norms among women entering engineering is probably greater than ever before, thus intensifying the problem. Though the women's liberation movement and the recruitment efforts of colleges have succeeded in expanding the number of female matriculants, they do not seem to be modifying their personal attitudes, expectations,etc. to make them more compatible with engineering norms.
5. The attitudes of society have changed sufficiently to make the idea that women are an expendable element morally repugnant.

What should be done? Based on the analysis proposed above, one solution is to alter the socialization of females so that the number of women reaching college age with these values is reduced, thereby enlarging the number of females that would be suited to engineering. Presumably if this were done, the applicant pool would be homogeneous, with no attitudinal differences that could be correlated to sex. Given current knowledge about the basis of sex related attitudinal differences, it is not clear whether this is feasible. However, if sex related differences are due to the socialization process of women, such a program may be feasible; if they are equally due to the socialization of men, such a program would seem to be considerably more difficult. Either way this option is a long range solution whose assessment would entail considerable speculation, since the hoped for results may never occur.

A second option is to work actively with females in the educational system to change their attitudes and values so that they conform more closely to those of practitioners. Put crudely, if the square pegs don't fit the round holes, then perhaps we should establish programs to do a little rounding. Such a program appears feasible since we know that engineering education does alter attitudes--or force those who do not want their attitudes altered along these lines to look elsewhere. Granted it does not now do it overtly or very well--at least if very well

is interpreted in quantitative terms--but it does do it. Yet to establish a program to overtly alter attitudes is repugnant to most educators: setting out to alter the values held by the females surveyed at Cornell, many of which are regarded very highly by the university community, to make these women more acceptable to engineering would be morally indefensible. Moreover, it probably wouldn't work, or at least it wouldn't work much better than it is currently working. Consequently, we can forget, it seems to me, any direct attempt to make women more narrow, more structured, less interested in social concerns, etc. as impossible; we ought to forget it, it seems to me, because it is totally undesirable and absolutely the wrong approach.

Professor Vera Kistiakowsky of MIT has suggested a third option that assumes that one does not undertake programs aimed at modifying the attitudes, perceptions and needs of the women in engineering, or that these programs are unsuccessful.[21] In this situation, female students will still experience changes in expectations and behavior through exposure to the educational system. In short, through their exposure females will become aware of the "system" and the difficulties they face, adjusting their expectations and responding behavior accordingly, i.e. they will begin to accommodate themselves. Given this, Prof. Kistiakowsky suggests that the best strategy is to prepare females to copy with the attitudes which they will encounter as a professional because these attitudes depend on the perceived rather than the actual performance of the person perceived, and are not likely to change in a short period of time. Thus, recognizing the difficulty of modifying the values held by the women, and given the virtual impossibility of modifying the engineering norms and attitudes held by the practicing professionals, the only possible recourse is to acknowledge the resultant conflict and to prepare women to cope with it as best they can.

Along these lines engineering institutions should include in their orientation course for freshmen:[22]

1. An awareness of the profession from a study of the engineering norms presented in the literature, from the experience of women in the profession, and from first hand experience through a week-long mini Co-op program.
2. An awareness of the values held by females and the unique position of female engineering students, encouraging students to retain their views and attitudes where possible, seeing them as a positive rather than negative asset.
3. A program that develops strategies essential for accomodation, particularly
    a. coping with discrimination and prejudice
    b. developing appropriate career plans and professional goals
    c. formation of support groups

A fourth option is to change the engineering norms, by which I mean those factors in the engineering environment and the organization of engineering activity which reflect the personal characteristics of engineers. This is the preferable solution, in my opinion, because women engineers represent the kind of engineer we want to produce. There is evidence for this in many of the reports in the literature concerned with the future of engineering and future engineers, as these suggest that engineers need a stronger humanistic background, that they need an expanded social awareness, that they need interdisciplinary studies, that

they need an orientation to human systems and human services delivery. From the standpoint of the historian of technology and science, a strong argument could also be made that this is the type of engineer we need if engineering is to respond to the social concerns and goals for technology and technologists and then help us avoid some of the mistakes of the past. And last but not least, there are futurists who believe these are the kinds of engineers we will need in the United States as we become more service oriented and less production oriented.[23]

In practical terms, the following steps may help in changing the engineering environment at the educational level:

1. Establish committees to evaluate curricula and educational programs to be sure they are compatible with the interest of women and the future of engineering. Committees may wish to begin by reading the MIT report "System Response to a Changing World" and by studying the research available on the interests of women. Programs that stimulate rather than stifle the broad intellectual interests of women should be recognized and rewarded.
2. Hire female faculty members, for whatever openings are available, particularly recently graduated female engineers who have a different view of engineering and its role, yet who remain technically competent.
3. Structure a faculty development seminar series aimed at making faculty members aware of the issues arising from the entrance of females into engineering. By and large, faculty are not cognizant of the attitudinal differences between male and female students--which may mean that the two groups are not optimally educated in the same way. The educational approach of faculty can no longer assume a homogeneous audience.
4. Sensitize male engineering students to the issues surrounding the entrance of women into the profession. Male peers need, in effect, to have their attitudes altered by the educational experience rather than reinforced. Specifically, this topic ought to be the subject of one or more lectures in every freshman engineering orientation course.
5. Establish seminar programs in line with the interest of women. Alternatively, unusual professional opportunities oriented toward the interdisciplinary interests of women ought to be the subject of one or two lectures in every freshman engineering orientation course.
6. Develop long range plans based on the assumption that the interest of women will continue. As an example, since it is known that women distribute in fields differently than males, the Dean of the institution should utilize this and other information in his planning with department heads, so that there is an organized forum for discussing the presence of women in the educational environment--and the fact that their presence demands changes.

At the professional level, the engineering environment could be altered as well. This could be accomplished if:

1. Those in managerial or recruiting functions became part of an educational program aimed at presenting the differences between male and female engineers and the implications of these differences for management. The latest research regarding both male and female engineers, particularly their psychological profiles and career plans, should become part of a systematic effort.
2. Management surveyed engineering employees to assess their attitudes toward women in the profession. Where necessary, educational programs for all engineering employees should be instituted. The remark, which I

heard last week, that "The problem with women engineers is that they cry in the ladies room for two weeks if you criticize their work" is a result of poor management policy.

3. Attitudes toward women became a factor in consideration for promotions for those in supervising or managerial areas. The remarks of women who have been supervised should be solicited and respected. Persons whose record indicates difficulty in working with women should be passed over.

4. Manpower specialists or managers were asked to rethink career development patterns and reward structures in the light of the following:

   a. Women and men do not distribute themselves in the same way in engineering disciplines. Women tend to congregate in chemical, civil, environmental, applied mathematics or industrial engineering--and rarely enter mechanical. To allow this to continue could be disastrous, as career areas in which women congregate--even though they are not a majority--suffer a loss of status and pay.
   b. Women do not distribute themselves equally in the engineering functions: they are more heavily concentrated in research, development, design, less often found in production, construction, administration, and management.
   c. Related to (b) women appear disinterested in the reward structure that appeals to male engineers and tends to lead them into management. High pay, responsibility, rapid advancement, etc. are not cited by females as important and this mitigates against their entrance into managerial functions, which has been the traditional route to recognition in engineering.
   d. Women have a number of traits that ought to be considered in restructuring career paths and rewards so that they are not viewed primarily as deviants, but as persons who are better suited or possessing special skills and talents.
   e. Women should be encouraged to formulate their ideal career plans and communicate these to management, enabling a closer congruence than will be achieved by managers acting on their own.

In conclusion, I wish to emphasize that I am not suggesting we produce "new engineers" in large numbers, I am not suggesting there is no place for traditional engineers, I am not suggesting all engineers be required to participate in interdisciplinary programs. I am suggesting that barriers exist for students with broader interests, that as a result these students have a higher rate of attrition. Even though it is but a fraction of the total attrition, the barriers ought to be removed wherever possible because we may be excluding those persons we wish most to retain if we are to graduate the "new engineers" of the future. I propose that rewards for broadness be made apparent, so that students with these interest are included rather than excluded. In my opinion, it is the person who does not fit the system who usually turns out to be the leaven which causes the bread to rise. It is essential to the life and vitality of engineering to retain persons with these characteristics. Many women have these traits, and women are now entering engineering in record numbers, consequently it behooves us to make the appropriate changes, for both men and women, at this critical point in time.

Footnotes

1. E.S. Rubin, "Engineering and Public Affairs at CMU". Copies available from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017

2. I wish to emphasize that I am working with statistical descriptions of groups of persons, and that I do not mean my comments to apply strictly to individuals within populations. The thrust of the paper has nothing to do with individuals or their education in an individual way; rather, the thrust is to discuss the production of a large group of individuals with certain characteristics and training. Clearly no given person within the populations discussed has exactly the properties of the group as a whole.

3. I do not pretend that the terms used here precisely describe current professional engineers. I wish only to indicate that historically certain characteristics have been established; I have not delved into the accuracy nor the immediacy of the personality studies of engineers because they are not essential to my argument. The relevant point to bear in mind is not whether males as a group do or do not share the characteristics of the new engineer, but to keep in mind that females do demonstrate these characteristics. The characteristics of males are a peripheral issue.

4. An Engineering Education Report: System Response to a Changing World. Center for policy alternatives, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1973. pp. 26-28. References to specific studies are carefully recorded in the Bibliography.

5. Ibid., Appendix, A26.

6. Ibid., p.24.

7. E. I. Holmstrom, "Changing Characteristics of Engineering Aspirants in Four Freshmen Classes." unpublished paper, Policy Analysis Service, American Council on Education, Washington, D.C.

8. M. Ott, "Attitudes and Experiences of Freshmen at Cornell".

9. Detailed analysis of the research at Cornell, which is much too long to present here, supports this point of view through the response to numerous questions in many areas. An in-depth description may be requested from the Division of Basic Studies, 170 Olin Hall, Cornell University, Ithaca, N.Y. 14853.

10. K. Feldman, The Impact of College on Students, San Francisco, 1969, p. 188.

11. E. I. Holmstrom, "Patterns of Change Among College Students Interested in Engineering" Policy Analysis Service, American Council on Education, Washington, D.C., p. 7.

12. S.S. Robin, "The Female in Engineering" The Engineering and the Social System, edited by E.J. Gerstl and R. Perrucci, New York, 1969, pp. 203-218.

13. Ibid., 211-212.

14. Ibid., 215.

15. S. Davis, "A Researcher's-Eye-View: Women Students, Technical Majors, and Retention." IEEE Transactions on Education, Vol. E-18, No. 1, Feb. 1975, p.25-29.

16. Ibid., p. 29.

17. Ibid., p. 28.

18. I wish to put the emphasis here on the work superficial, by which I mean career expectations and rewards that are beyond the intellectual content of the job itself. These are factors that could relate to any profession irrespective of the nature of the work. The point is that if you took away the intellectual interest and the social motivation of women they would have little reason to remain in engineering. For further discussion of the attitudes of practicing professionals see "Career Satisfactions of Professional Engineers in Industry, Professional Engineering Conference Board for Industry, Washington, D.C.

19. H.G. Kaufman, "Young Women in Engineering: A little bit better than the men" New Engineers, February 1975, p. 31. The data I have used here is unclear in the sense that Kaufman does not record whether the data was obtained when the sample was in college or when it had been in the work force for ten years. I have assumed the latter. If the former is the case, it alters the argument only slightly, since this would mean that female students now entering engineering are different in their attitudes from those graduating in 1961. Either way, the current group of females has different interests from the "normal" group.

20. For statistics on enrollment, manpower forecasts, etc. the best source is Engineering Manpower Commission, Engineers Joint Council, 345 East 27th Street, New York, New York 10017

21. V. Kistiakowsky, private correspondence, May 1975.

22. These suggestions are mine, not those of Prof. Kistiakowsky.

23. Op cit., "System Response to a Changing World."

Chairperson's Questions
(The following questions were presented to the panel for consideration)

1. If it is true that women engineering students show less interest than male engineering students in managerial aspects of the profession, how much of this might we be able to relate to their perception that they ought not to be (cultural stereotyping) or that there is little use in displaying such ambition? Role models are sadly lacking.

2. Women engineering students in the study are characterized as showing more interest that men in contributing to society and helping others:

a) Isn't it true that their entire generation displays more interest in these matters than used to be the case?

b) A nineteen year old student in 1975 would have had many of her basic values programmed into her system by or before 1966 (when she was 10 years old.) The society of that time contained the message that helping roles were appropriate for women. Can we expect the student of 1994 to be quite different in her orientation? Do we need to wait that long? What is our interim strategy? How much impact can a small group of women engineers have on their environment?

3. It is claimed in the paper that women engineering students bring feminine norms to engineering and that these norms produce conflict and reduce performance. Perhaps there are other reasons for such difficulties that should be discussed. For example, when over-zealous recruiters (who could be from industrial or educational institutions) paint a picture that is too rosy, the young woman student can experience conflict in the actual student environment (negative messages from male students, social isolation, heavy work loads, etc.) She can react with enough frustration and disappointment to leave the system. Should academic institutions try to prevent this? What realistic measures might be taken?

4. Are cooperative education programs, with adequate follow-up, a possible approach to the retention of women engineering students? Possible grounds for a positive response might include:

enhancement of basic skills and self-confidence

overcoming a possibly deficient background (in use of tools, etc.)

opportunity for some reality testing re working with men, and working in engineering

other (your thoughts are solicited)

5. There seems to be an implication in the paper that women students should be helped to accommodate to existing situations re coping with discrimination and prejudice. The other side of that is that male engineers and supervisors sometimes need guidance, too, to change their attitudes. Is there anything an educational institution could or should do to apply pressure toward this end?

6. Qualities listed in the paper as being identified with women engineering students (humanistic interests, expanded social awareness, orientation to human systems and human service delivery) are the very qualities sought in future engineering managers. The paper further suggests that although these traits are desirable they can be a liability under the present system. What can universities do to close this gap? Should we be encouraging women engineering students to opt for some management training while they are in school? Would there be any relationship to retention if we did?

7. I agree that many faculty are unaware that psychological differences between male and female students might be important in engineering education. However, I would view them as retention factors, and not suggestive of the possibility that women should be educated differently as engineers. What is the point of view of industrial representatives on this?

8. How can management best utilize any psychological, tempermental, or professional differences which may exist between men and women engineers?

9. Is there any real danger that any engineering specialty might become so dominated by women as to lose professional stature?

10. It is suggested that women are not interested in the reward structure and hence are not motivated into management routes. An alternative interpretation would be that they have simply accommodated to the facts of life in industry. What do working women engineers think?

11. Is it really true that communicating career ambitions to management will open all the doors? Jeopardy situations could be created just as well, couldn't they? Perhaps we should be encouraging women to be perceptive in their working environments, and to be prepared to move on, if need be, in order to advance.

Irene C. Peden

Dr. Irene Carswell Peden, Associate Dean of Engineering and Professor of Electrical Engineering at the University of Washington, Seattle, is noted as an engineering educator, as a radio scientist, and as a leader in the effort to involve women in professional engineering careers. The Society of Women Engineers conferred its highest honor, the Achievement Award, upon her in 1973 citing her contributions to radio science and engineering education. Dr. Peden, who holds a B.S. degree in electrical engineering from the University of Colorado, and the M.S. and Ph.D. degrees from Stanford University, all in electrical engineering, has been a consultant to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and has served as a consultant to the Commissioner for Science of the U.S. Food and Drug Administration (FDA). She is the 1975 Vice Chairman of the Institute of Electrical and Electronics Engineers Educational Activities Board. The first American woman engineer/scientist to conduct field work in the interior or the Antarctic continent, Dr. Peden has produced many major publications including a number dealing with radio propagation and the polar ionosphere as well as others on the dielectric and loss properties of the Antarctic ice sheet at very low frequencies.

Session VII: Responses to Robert Gardner's Paper

J. Melissa Brown: I'm pleased to be here. I just arrived last night, so I've not been in on the previous part of the conference and I'm not really aware of all the things that have been discussed before. Each of the panel members did receive an advance copy of Dr. Gardner's paper, and the presentation today varied a little bit from that, but fundamentally we have the same kind of information. I was pleased upon meeting Dr. Gardner last night to find that he's young and hopefully resilient, because I had a somewhat critical reaction to his paper as I read it, and I had visions of shattering the fragile ego of a septuagenarian who had devoted his entire life to this endeavor.

In discussing the paper, I must first confess a bias. I have little interest in the concept of norms for analysing human achievement. They're as useful to me as the statistic that the average household has two and a third children. I have yet to see that third of a child. The majority of Dr. Gardner's paper I did not find very persuasive, for the conclusions appear to me to be little more than personal assertions. In short, I feel the paper suffers from the very thing that our dinner speaker warned us about last night: assuming too much from too little. In particular, I jotted down last night the following six items as a few examples of the many opinions disguised as facts that I found so disturbing in the paper.

First item: The statement was made, "If we accept the Cornell sample as being representative,we can conclude that..." and a series of conclusions follows. Yet we have no way of knowing whether the Cornell sample was reasonably representative or not, for we know nothing about how it was conducted. How many people were surveyed? How were they selected? How were the questions raised? Were the responses yes/no or on a scale of one to five? And most importantly, where is the analysis of statistical significance of the results? Without this kind of information, I am exceedingly wary of any conclusions reached from the survey. For example, in the questions regarding reasons for entering engineering, if a significantly lesser number of women that men was surveyed, as it was indicated this morning was the case, then the resultant curves for women will be far more sensitive to aberrations, and the two curves really are not comparable at all.

Second item: The interpretation of numbers in Dr. Gardner's paper seems to be bent a little out of shape. For example, survey results showed 20% of the women saying that high earnings were a reason for their entering engineering. Forty percent of the men gave the same response. Based on this, the dramatic conclusion is reached, "Without doubt, these women do not relate to the reward structure that currently exists for engineers in the profession." But 60% of the males, well over half, also did not relate to the reward structure, and there is no such conclusion stated for them.

Third item: Throughout the paper, there was frequent reference to the fact that women will never be numerous in the engineering profession

because they generally do not adapt to the system. I would just as readily contend that the system will naturally adapt to them. If, in fact, women do not fit the so-called "engineering norm", then any significant number of them entering the profession will automatically shift the norm, if norms are really what are being discussed.

Fourth item: It is concluded that lower grades and lesser faculty acceptance for women are the direct results of their introduction of feminine norms, yet there is no stated evidence to support this. My observations are that faculty rejection is frequently based on simply being female, without regard to whether the woman exhibits masculine or feminine norms.

Fifth item: There is reference to the exponential increase in the number of females entering engineering, then the assertion that we know this is not due to a change in the socialization process because socialization processes are simply too complex for expontential change rates. I'm not sure of Dr. Gardner's definition of socialization process, but I would contend that the process of unleashing already bright, capable, interested minds for pursuit of a challenging life is far different from the process of converting an agrarian society to an industrial one. It therefore might very well exhibit exponential changes.

Sixth item: There is the contention that women are "...not oriented toward climbing the management ladder, but in making a contribution to society and in being helpful to others." These are in no way mutually exclusive. If women do ignore the management ladder, it is probably realistically based on management's traditional attitude toward women. As the attitudes change, women can both climb the management ladder and contribute to society, just as many men do.

I'll stop with those few comments, and assume that the most interesting observations will come out of our open discussion with you. I would close by saying that there is much to be gained from many of the consciousness-raising programs that Dr. Gardner has suggested, but I object very strongly to the thesis that women must be educated differently from men. And I have seen from experience that role models and a tolerant environment are the basic requirements for motivating women toward successful technical careers. From my vantage point, the two key processes that will ensure a healthy number of professional women engineers are: One, an emphasis on exposing them throughout their lives to successful role models; and two, enforcing the legislative requirement that women be given access to rewarding jobs. These will do much to change the existing attitudes of both men and women, although many members of the old school will simply have to die off before there is a full cultural awakening.

J. Melissa Brown

J. Melissa Brown is currently on a one-year leave of absence from Metcalf and Eddy, Inc., to serve as a White House Fellow in Washington, D.C. During her fellowship year, Melissa has been assigned to the Department of State; she is now serving as Special Assistant to the Under

Secretary of State for Economic Affairs. Born in Wyoming, Melissa received a B.S. with highest honors in civil engineering from the University of Wyoming in 1962. Since that time, she has worked in sanitary engineering design and planning for various consulting firms in Utah, Germany, New York, California, Oregon, and Guam; additionally, she was a mathematics instructor for a year in a private school in Switzerland. Most recently, she was Project Manager for all solid waste management projects undertaken by Metcalf and Eddy in the western United States. Ms. Brown is a registered civil engineer in California. She has published numerous articles and is a frequent speaker at professional conferences where she discusses with fellow engineers, engineering faculty members, and students the opportunities for women in engineering.

Marilyn Sessions: I didn't prepare statements such as Melissa's on Dr. Gardner's paper. I prepared my own view according to some of the things I saw in his paper. I also farmed his paper out to four young women engineers in DuPont: mechanical, civil, electrical, and I'm metallurgical, engineers. All of us reacted basically the same, but then we do fall in the category of those who made it versus those who dropped out, so possibly we're closer to the male engineers anyway. I think interviewing freshmen and taking these norms and their ideas as facts that will hold with them throughout their education is somewhat faulty because if I were interviewed eight years ago when I was a freshman I certainly would not have said that I had management aspirations, which I have now. I certainly wouldn't have said that I wanted to go to graduate school, which I did, because I hadn't been exposed to these possibilities at the age of eighteen. I think young men more easily know what they want to go into because they have the role models to identify with because of their fathers and other business associates. I think the women have to develop their aspirations along the way, incrementally, and so a freshman is quite different than a sophomore, who is quite different than a graduate student, etcetera. So I would disagree when you said that the people who were interviewed ten years out would have stated the same statements as ten years ago when they were freshmen.

I think the fact that women segregate into certain industries or areas of engineering is a natural selection. Probably the men who have more broad interests segregate into the same areas that the women do. No one's been upset, because they didn't wear skirts, that these men segregated in the same ways that the women are now. I would hate to see engineering become so bland that anyone would go into any discipline. Mechanical engineering might not appeal as frequently to women, but that's because of its nature, and if a woman wouldn't enjoy that it shouldn't be changed in order to accommodate her.

I think there are a few ways to improve the education of women, but it's not because they are women, it's because of these norms that Bob has identified. I think many men hold these norms also. A man who has broad interests and wants to interact with people, if he's aware of it, will naturally use his engineering education to go into marketing or go into

management. If a female is aware that these alternatives are available, then she also will aspire to go into, let's say, marketing, into personnel relations, or into management and not to sit on a draftboard and be a design engineer. But these opportunities have to be made known to her early, or known to anyone early. When I was a freshman at Cornell, we had no career guidance, and I think most of the engineers that went through graduated with the idea that we would be engineers when we walked out, and it was only during the interview process with companies that we became aware that there was really quite a wide range of possibilities for us to enter: going into graduate school in law, in business; marketing, manufacturing, production. Service sales is a fascinating area for an engineer to be in, where you interact with vendors and you respond to their problems, plus you do a technical job. This information normally is not made available to the freshmen. If the female or the male with these particular broader norms is aware of these possibilities, then going through a structured discipline will be worthwhile, because they know they can spread out when they graduate.

Marilyn L. Sessions

Marilyn Landis Sessions received her B.S. in Material Science and Engineering at Cornell University and her M.S. in Metallurgy and Material Science at the University of Pennsylvania. She is beginning night classes in business at the University of Delaware. Employed as a metallurgist in the Engineering Technology Laboratory of E.I. Du Pont de Nemours & Co., she previously worked with General Electric and as an electron microscopist at the Cornell Material Science Center. Ms. Sessions is a member of the American Society of Metals and the Metallurgical Society of AIME.

Sherry Koenig: You may want to regard my remarks somewhat differently than those of the rest of the panel. I'm not a practicing engineer; I'm a graduate student in engineering (Industrial Engineering and Operations Research) here at Cornell. I want to respond with two comments to Dr. Gardner's paper. The first one is that I react very negatively to the idea of a specialized education for women engineers. From my own background, I feel that that kind of education will tend to alienate and isolate the women engineering students rather than bringing them closer to their male counterparts, or bringing their male counterparts closer to them, in either sense. I think that that kind of isolated education, even if it consists of just one course in the freshman year, is not the solution. It has not traditionally worked our in bringing other minority groups closer to central norms. A great deal of the reassurance that women engineering students need to continue, I think, in their undergraduate years is an acceptance and acknowledgement by their peers. I don't think a separate course will achieve that acceptance.

The second comment I'd like to make is that I think it's necessary to take the responses of the freshman engineering women with a grain of salt. I think their ideas may change somewhat by the time they finish their undergraduate education. I'm certain that my ideas about the

profession of engineering changed a great deal over those four years. The reason that I think they responded to the questionaire by indicating that their view of engineering was to look at it as an academic pursuit rather than as a profession or looking at the rewards of the profession is that in high school they received reinforcement for academic achievement, and they have no role models in the professional world. I think that in the four years of an undergraduate education, if they do perceive themselves in a role as a professional engineer, their ideas will begin to change and they'll be able to say that they look to engineering as a profession, as a means of helping others, and as a step toward a management position. In a way, I think that the job of the engineering educator is going to be to present these women with role models of professional engineers, and, to tie this into the first point, I don't think that these role models should be presented just to the women. I think it is very important that they also be presented to the men, since the guys in the engineering profession, their peers, will have to accept them as women engineers, just as they will have to fill the role of a woman engineer. So I think that the idea of presenting role models and presenting to these women the ideas and the norms of the engineering profession shouldn't be an isolated thing. It should be something that the men and the women in engineering participate in together.

Robert Charpie: My point of view as I express it today will necessarily be very different than anyone else's here. After all, I guess I'm the only person up here who isn't an engineer. And in many other ways, I am a perfect choice to stay at home and not talk, because my experience with women technologists, scientists, and engineers has been, if extensive, at times shattering. I finished my formal education two recessions ago, in 1950, and I well remember receiving letter after letter from places where I'd applied for employment saying, "We aren't hiring physicists this year." In desperation, and with a large measure of good fortune, I managed to find a job in Oak Ridge, Tennessee, although I couldn't get into the Oak Ridge National Laboratory. They weren't hiring physicists either. Two years later I was Assistant Director of the laboratory, but in the interim I was hired to supervise in part the disassembly and phasing out of the electro-magnetic isotope separation facilities in Oak Ridge to return all the silver to the Treasury. And as the most junior member of that group, I found myself on the swing shift with some kind of fancy title like superintendent of a building that had about $800 million worth of silver in it. There were two hundred and fifty one people on this swing shift; two hundred fifty women and me.

My second experience with women technologists was nearly five years later, when I was one of the "lucky" people who was selected as an outside expert by a young woman engineer, a freshman engineer, who had reached the $64,000 level on the $64,000 Question program on national TV. And if you remember the isolation booth, the few of you who are old enough to remember it, you know that the visiting expert could go in and give all kinds of help. Well, I got in the isolation booth and it was perfectly obvious that she didn't know what she was doing and that I was going to have to work the problem for her. After monkeying around with it and trying to

get her to work the problem, with about thirty seconds to go I dashed off the answer. She won the $64,000; I didn't get even a letter of thank you, nor any of the money.

My look at engineering will not be through the eyes of those who appraise the changing qualities of the matriculants in engineering, but really a look at the enterprise. Ask yourself the questions: What's it like? How's it doing? Who's in it? and What's with women? First off, I would say that if I knowingly were in the business of hiring engineers who would fit Bob Gardner's norms for engineers, male or female, I'd quit right now. I wouldn't have one of those people who is exactly his description of a dull, uninteresting, perfectly mediocre in every respect, and all-he-wants-is-my-money engineer. And my impression is that, if that's the norm of engineering, students, practitioners, whatever, that somehow there is a force at work which causes the totality of what we call engineering to turn out rather differently than it ought to given those inputs. It's my impresssion, for example, that engineering per se has been a very exciting activity. Some of the most challenging and stimulating things that our civilization has done have been articulated through engineering. It seems to me that somehow there is a dynamic which must bring into engineering some skills, some sense, some judgements, some experience, some impresssions about the future, some realistic evaluations of the mistakes of the past, that makes the overall result turn out better than that collection of clods we heard described, male or female, could possibly have done. And I submit that there are some dynamics that we all know about that get completely overlooked if we look only at the matriculants or even if you only look at those who are ten years out. The first thing that happens, not uniquely among professionals, but included with all other good professionals, is that people we call engineers or technologists continue to learn. Engineering is one of those professions where the learning process goes on until ten minutes after you quit, because the technology, the materials, the problems, the state of the art that you work with today is dramatically different from that to which you were exposed in your days at the university. And so engineering is a growing profession, growing in the sense of the demand for currency, and somehow those who are best at it are those who continue to learn with it. The education process, the selection process, goes on over a long, long period of time. It is not in the first or the second or even the first four years of undergraduate school.

Secondly, engineers, more so than any other professionals I know of, save perhaps lawyers, and for the same reason, change careers. As individuals, it is rare to find a practicing engineer, except at an engineering firm, and a relatively small fraction of all engineers are in engineering firms. A person whose undergraduate education was engineering may wind up anywhere in our society. I run a little company, and I've looked at the origins of our management. It's a highly technical company; we d about a half a billion dollars a year. And if you take the top nine people who are the insiders who control the whole world-wide complex, seven of them had their first degree in science or engineering, one in law, and one in finance. If you take the twenty-five people who are the general managers of the enterprise at all the offices of the firm, who control the

destiny of the company in detail on a day to day basis, you find that nineteen of these twenty-five had their first degree in engineering or science. I happen to think that's a weakness of our company. It's a terrible weakness, in fact, to discover that seven of those top nine fellows' first degrees were in Physics. I happen to be the only one whose Ph.D. is in Physics; all the rest of them had the good sense to go get a degree in something else. Most of them have a Masters degree in Business Administration from places like Harvard and MIT, for example, but then I'm running the place and I'm the only one that's never been to business school. I think you'll find managers of investment firms, important officers in manufacturing firms, people in marketing and advertising as well as production and research, whose original education was in engineering. And it's my view that this renewal process of engineers, which I insist is part of the practice of engineering, is part of the people who make up engineering, and they use it even though they don't recognize it as something that was built into them through the demands for change and currency in technology in their undergraduate days.

If you take a look at the eighty-six people who were elected to the National Academy of Engineering this year, it is interesting to see that seventeen of the eighty-six have never had one moment's education in engineering. I'm one of them. And yet those seventeen people are somehow sorted out by the engineers for the highest honorary recognition in engineering. They say, "We want him as a member of the National Academy of Engineering because of his contributions to engineering." Think about it. One of the roots through which engineering gets enriched, just as engineers enrich other activities, is by acquiring people whose initial conditions were not engineering. Some of the finest engineering done in this country, in the aerospace field, in the nuclear field, and now in the medical field, some of the pioneers are people drawn from completely other walks of life, often science. And I think that a conversation about engineering which doesn't talk about science and engineering runs the risk of dealing with a sub-optimum population, and thereby leading us in studies of group traits and assets and deficits into wildernesses of error.

I also point out that it's nothing new to talk about the education of engineers in terms of what it should be besides those one-two-three courses in engineering. In the 1930's, Bob Dougherty at Yale imposed very severe restrictions in the Sheffield School on what it took to get a degree in engineering. He took those with him when he went to Carnegie in the early '40's, and,by the end of World War II, it was commonplace,as it is here at Cornell and everywhere else that all of you are associated with, to have very important humanistic demands as part of the necessary training of the good engineer.

I would argue that there is an important change going on in the profession of engineering and the way it thinks of itself over time, and that much of the debate about matriculants fails to recognize how the profession sees itself. It is, for example, perfectly clear that the fraction of engineering that you might call hard-hat engineering, civil construction, oil field work, etcetera, is very much smaller today than it was fifty years ago and it's been getting steadily smaller. It will never go to zero, but

it is not all of engineering; it is now some of engineering. In the second place, the engineers themselves are drawn from different backgrounds. Fifty years ago, almost fifty perconet of all entrant engineers in the engineering schools of the United States were either first generation U.S.-born or came from below the fiftieth percentile of economic family life. Engineering has been one of the traditional routes taken by immigrants and economically depressed people in the ethnic minorities that made up this country in the early part of this century in which they ran into the least trouble and had the least difficulty in expressing themselves and becoming successful. Hence it's no wonder there is focus on growth, on management assignments, on salaries. But changes are taking place, and our engineers come from different kinds of family backgrounds. There are also changes in attitudes going on in society about professionals in general, how they think about themsleves and how we think about them, outside the engineering profession; the legal profession, the medical profession, and so on. Time alone generates some of those changes in attitude. It hasn't been very long ago, you know, that the women in the medical business were a relatively small fraction, until we observed that 70% of the doctors in the Soviet Union were women, and we had to figure out why that was, and what was driving that system. You find very rapid changes going on in law, in medicine. The Women's Movement itself has generated as awareness among company managers. But, most of all, the thing that is changing the attitudes of people about the acceptability of women engineers and women professionals in general is the shortage of people, the need. If nothing else happened, if the universities tried very hard to keep women out of engineering, if the professional engineering boards refused to register women engineers, if all of the organization in the system lines itself up, as none of it will, in opposition to women engineers, the sheer fact that industry wants women engineers, because we observe that 50% of the people are women and we don't have enough engineers, is in the long run going to bring them out of the system. There is opportunity for those, maybe not the "new engineers" that Bob Gardner talks about, maybe the small, dull, normalized engineers who are the women who look just like the dopey men, but we're going to get them. If fifteen thousand won't do it, and thirty won't, forty-five or sixty will. And this society is not going to stand still; we've got business to do, and we'll get them and women will respond to those kinds of judgments.

Incidentally, the notion that women aren't interested in managerial growth and in compensation in my view and experience is not only ridiculous, it would be an absolute fatal mistake for a manager to assume that. I have in my company three perfectly obnoxious people, who are absolute geniuses but they're obnoxious about their titles and their salaries.... These three women have given me individually more trouble and collectively most trouble, about their titles and their salaries and their growth and their management ambition. Every one of them wants my job, and they want to know if I'm going to take early retirement. Women are aggressive, they're capable, and they ought to be aggressive. We're in the midst right now, as most industries are, of reducing our staffs in the face of rapidly rising costs. When the manager in one of these departments laid off a couple of men who'd been with us a number of years and had a couple

of young women in the group, he had to stand up in front of his organization and say that he did it on the basis of quality and not seniority. The whole situation would have been better off if nobody had asked, because it did create problems, but that's the way it goes these days.

Two more points. There are, I find, in commercial enterprises, among professional, technically trained women, two classes of women that I would sort out for your consideration. First, there is the group whose objective is growth, management success, recognition, and often these women are younger, often these women are single, but not always to both of these. Another group is the women who have made an accommodation themselves to the company, to the system, to their ambitions, to family life. And I find that this accommodated group which knows what it wants, and the totalizing of the personal assets includes that accommodation, is a more discernible group from the driving, aggressive, what you might call male-typical group. There are no external differences between them, in the quality of their education, in the length of their skirts, but there is a discernible difference in their ambitions. And, I think, one of the guidelines a manager has to recognize clearly is that he has to understand for each woman in a position of major responsibility within his organization how she describes herself. Aside from that, I have never found it necessary to make a single accommodation for women.

To summarize the position I take, it goes like this: If you're going to look at women in engineering, you run the risk of looking at too small a group of people in a sub-optimum part of our society. Sub-optimum with respect to your ability to describe it and draw inferences from it. However, it is so important to this society that we increase as well as renew our scientific and technological expertise, that we can't afford to ignore the problem. So the bottom line of my argument is that, even as today, tomorrow the fruits of success in this society importantly are going to flow to the people whose roots are in science and technology, and who turn their expertise into the great buildings, and buildings in the larger sense, the great enterprises of this society. And women will participate in full measure and on an equal basis with men, simply because we have to have them. We can't afford to let that half of the society not participate. Fifty percent of the capability is there. And I believe that's the way it's going to be.

Robert A. Charpie

Robert A. Charpie has been President of the Cabot Corporation since May, 1969. He is a graduate of Carnegie Institute of Technology where he received his B.S. with honors in 1948, his M.S. in 1949, and his D.Sc. in Theoretical Physics in 1950. Following his graduation, he joined Union Carbide Corporation on the staff of the Oak Ridge National Laboratory as a physicist. In 1966, he was named President of the Electronics Division of Union Carbide. He became President of Bell & Howell in March 1968 and served in this capacity until joining Cabot Corporation in May 1969. Dr. Charpie is a fellow of the American Physical Society, The American Nuclear Society, and the New York Academy of Sciences. He serves on the visiting

committee for the Department of Nuclear Engineering at M.I.T., the visiting committees for the Deaprtment of Engineering and Applied Physics and the Department of Physics at Harvard, and the visiting committee for the Department of Physics at Carnegie-Mellon University.

Shirley Holmgreen: I guess I would like to get back to some of the particulars of the paper. I must say that I agreed with a great number of things that you said, Dr. Charpie.

One of the things that we've read and heard during this conference is that women are significantly more interested in the social aspects of the engineering profession, and that contributing to the betterment of society is the most important thing to them. And my instant, gut reaction to that, if you'll pardon the expression, is that you probably got the answer that they thought you wanted to hear. After all, since the cradle, women are taught that really what their aim is to do is to please people and be nice. Since their choices were limited to one in that case, they chose the one that seemed like the nice thing to say....Women in this country, indeed 70% of the forty million women who work, and I include the engineers in this, do so because they are single, divorced, separated, or married to men who make less that $7,000 a year. Now, the imperative to eat, plus the internal imperative, you can call it the work ethic if you like, seems to me a much likelier reason for people wanting to become educated and to have a profession.

Another comment, and I'll be a little more specific perhaps than Dr. Charpie was, (concerns the finding) that women are not interested in managerial or supervisory positions. And I wonder if that's really fact or if it's merely (the result of) a realistic appraisal of career possibilities. Do women not wish to appear destined for failure by aspiring to something that so few attain? Do they not want to scare off a potential employer by mentioning that they want to go into management the first time they ever walk into the office to talk to them? You may have heard of a little test given by psychologists in which they checked the reactions of various people who came home at night and wanted to go upstairs and they found a panther on the stairway. And they wanted to get up. Now what would they do? How would they cope with this problem? Well, some would simply plow ahead and assume that that panther had to be a figment of their imagination, and they got pretty well chewed for it. Now some of us older women engineers bear a few scars from doing just that, before we found out that the panther was indeed real. Others looked around for a back stairway --how you could avoid the whole thing by going around and going upstairs in a different way. A lot of us have learned to do that through the years, and I must admit that a lot of us have been fortunate enough to find a man in a position to lend us a ladder to get up the other way and not have to go through the panther. But still others have said that they really didn't want to go upstairs anyway, and they just avoid the whole problem. And I suspect that the answers you get are from people who figure they can't attack the panther right now; they're not well prepared and so they give you the other answer.

Now, you've suggested that special courses for credit be set up to take care of these special problems that women students apparently have. Well I hope I'm not displaying the "I made it the hard way, why can't you" syndrome when I say that I think that's very much the wrong direction to go. The fact is that women will be very much more alone when they enter industry than they are in school, especially now when they're entering in very much greater numbers. If you insulate them from the competition and the association with men, it merely delays the shocks that they're going to get eventually, and perhaps at a more critical time in their professional careers. That competition can be made very much more bitter to the men by the knowledge that women received all kinds of special treatment along the way, and they'll remember that.

You said that courses to develop career plans, professional goals, and how to cope with the problems, should be made available to women. You said that they are already available to the men students, and yet, being available, still 50% of the men students drop out of school as well, so really what good are courses like that doing? Instead, I guess I would have you reverse the process that I've seen happening throughout the years in engineering colleges, and that is to remove the engineers from association with other kinds of students. Don't teach them them bone-head English for engineers, because, from the looks of the reports that I see day in and day out in my work, just plain English would do very nicely, thank you. Don't teach them humanistic social studies for engineers, or economics for engineers. Let them mix it up with the fine arts students and the education majors and the psychology students. They might enjoy each other, and they also might learn something from each other. And, in the process, they may develop some of the qualities that are attributed in the paper to women students, who,in living among other women, at least until recently that is, have normally been exposed to a wide variety of interests, and therefore enjoy a lot of things that the men students don't.

Several times you've also said that women distribute themselves differently from men, meaning both in discipline and in function. I would submit that you've missed the point. I would suggest that they've been distributed in that way, not that they've distributed themselves. They choose those areas where they're allowed to work, and in the same way that in recent times men in hordes have chosen to abandon the study of aeronautical engineering. The men don't think there'll be jobs there for them; they don't study it even though their interests may lie in that direction. Messages about career limitations get through loud and clear to all of us.

And lastly, I would like to say that you've surprised me in the last two days by not mentioning even once, from all the universities that have been represented here and all of the discussions I've heard, the usefulness or possible help that you might get from technical and professional societies. I'm excluding the Society of Women Engineers there, you have mentioned that, because I think that's a horse of a different hue. It's not what you would call strictly a technical society, because it embraces all of the disciplines and therefore it's a little difficult for it to be very technical. I'm talking about ASME and IEEE and ASCE and AIAA, all of the societies that each of us should belong to and can gain a great deal

from. It's an excellent way for a young engineer, a man or a woman, to meet experienced engineers, to chat with them over a drink and dinner, and to get some of the visual and verbal cues about how their disciplines are practiced and how they should be practiced and how those people who are involved in it and interested in it do practice their disciplines.

Shirley A. Holmgreen

Shirley A. Holmgreen was born and attended public schools in Bryan, Texas. She received her B.S. in Aeronautical Engineering from the University of Texas in 1952 and the M.S. in Aeronautical Engineering from the University of Washington in 1962. Presently she is employed by the Boeing Commercial Airplane Company, Renton, Washington, as Senior Group Engineer of the 737 Aerodynamics Staff and the Competitive Analysis Group. Before joining the Boeing Co., she was employed by Monocoupe Aircraft as a designer and by Bell Helicopter Company as a flight test engineer. Ms. Holmgreen has served as Chairman of the American Institute of Aeronautics and Astronautics, Pacific Northwest Section, and Chairman of the Society of Women Engineers, Pacific N.W. Section. She is a member of the National Organization of Women.

Irene Peden: Our thanks to all the panelists, and I think perhaps before throwing it open we should give Bob a chance to say a few more words if he wants to at this point.

Bob Gardner: Well, I suppose everybody likes to defend himself, but I'm not sure that it would be constructive for me to try to do so. I'm not surprised at the reactions; in fact, they were about what I expected. I do think, however, that most of the comments have really concentrated on the things that caught gut emotions rather that the issues. The issues as I see them are that we now have on our hands a group of freshman women engineers, some four thousand in number, who clearly have, at least on the basis of the Cornell sample, different characteristics than the males. There is good reason to suspect that they're different than what was historically here. I suggest that much of that's due to recruitment, and in fact we now have a population of females who are entering technical education because they've been recruited there. Now as I see it, there are two ways to go. You can say, "O.K. We'll just let things run as they are and those who can't handle the conflict, those who aren't like the other engineers, will drop by the wayside." That's one alternative. We can simply do nothing. The other alternative, it seems to me, is to say, "These people may have some attributes that would be very good for the profession, and in order to get them into the profession we may want to offer some special help." Then the question is, "What happens if we take that tack and those people then start appearing on the job market, only to find that they have this conflict all over again and they might drop out there?" So the question I would raise is not simply whether engineers are clods or not; I think that's an irrelevant point. The point is that we have a significant number of women engineers who are in fact different from the engineers who have gone before, and the question is: Are they totally useless to industry? Does industry want us to stop recruiting because they

don't want these people? And I think that's the key question, not whether these people have experienced changes in terms of what they are and what they were ten years ago. The question is, I think, "Is there a new crop?" I think the evidence is that there is a new crop, and what are we going to do with this new crop? That's what I would say the issue is.

Irene Peden: Let me just make one comment in response to that. It's absolutely true that there are more women entering engineering curricula than ever before. It's absolutely true that people have been out recruiting women engineering students. I'm not sure that there is a one-to-one relationship there, and the reason I'm not sure is that I don't know how to sort it out. But I would say this: there are several reasons that I can think of why there might be more women entering engineering curricula now. One of them would be the recruiting. Another one would be their knowledge of the presence of jobs for engineering graduates, and of the particular doors that are open to women and minority engineering graduates. And I think that engineering students are very well attuned to what the job market is. Another aspect would seem to me to be related to a new acceptance of themselves and a new perception of the goals that they might be able to reach on the part of young women, and this does affect high school women, and it affects freshman college women and all the way through. We're seeing a different group with different attitudes toward themsleves. They are cooler, they are more sure. I relate that to civil rights movements of the recent past and other factors. Another factor I think might be what I see as a turn-around in the attitudes of young people in general toward science , engineering, and technology. Those were dirty words a few years ago. I believe that the young engineering students that we are seeing now in the universities, there are more of them, both men and women, are more accepting of engineering as a tool with which to be helpful in solving the problems that this society has. Instead of attacking technology, they're saying, "Maybe it's a way of solving some of society's problems and maybe I can help."

Session VII: Questions and Answers

Dean Skalka: I wanted to point out a feeling that I had. Bob, you pointed out some differences in attributes of the new crop of engineers, but you left the impression that these are negative and not to be desired attributes. I would venture that these are things that are going to be of advantage in a career. The other point I wanted to make is that all of the remedies that you were talking about had not to do with the negative attributes of the women, but failings of the system within the university and industry, having to do with awareness, with accountability. These have to do with overt and maybe more subtle sexism in industry and in the universities. So you are pointing out where the problems are, and they are not as much in the hands of the women. I am from Bell Laboratories, and we have about seventeen thousand on the staff, of which, on the professional staff, administrative and technical, we have about a thousand women. In engineering we have about three hundred women. We are very selective. Both the men and women are extremely well-qualified. We hire people because of their creativity and imagination. So this is an asset that out industry is looking for. And, I can assure you that the women in our industry are very much concerned about salary, about promotion, about management, about acquiring the kinds of jobs that will be a platform to show off their creativity. Women are concerned and they're not willing to sit back.

Bob Gardner: Maybe I should clarify my argument. In my own personal view, Dean, I see the characteristics displayed by these women as being extremely desirable. But I think from the standpoint of what I will again call the norms of engineering, they're viewed as undesirable. In fact I am willing to intervene in the education of these women to make sure they stay because I want to see them passed on to change the profession. If I or somebody doesn't intervene, there's every reason to believe from the data that they're going to drop out, will never be passed on to the profession, will never have their impact on the profession. And so I guess my argument is that I do believe these are positive characteristics; I do believe the system is what needs to be changed. I don't believe in separate programs for men and women--what I said was that lectures relating to the needs of women should be included in freshman orientation courses, which are now totally male-dominated. That is to say, at Cornell we do not have a single woman engineer among the group of lecturers that addresses each freshman class each semester. We do not deal at all with the issues that are relevant to females in engineering. I'm simply suggesting that we make some accommodations in out system to allow broader liberal electives, that kind of thing, that enables these women to stay, to take down all the things that are frustrating them and causing them to leave.

Marilyn Sessions: When you made the comment that you thought male faculty and students ought to be made aware that women were different, I know every female that I spoke to, and I'm sure those on this panel, reacted very strongly against that. The idea of accommodating freshman women I think should be very subdued and subtle. And a simple accommodation which I did not mention previosly was that when people enter engineering, there is usually an assumed level of competency from the faculty. They assume that this person has torn apart his father's car and has taken mechanical drawing and shop courses in high school, and this is not necessarily true in the case of some males and in the case

of probably a majority of females. I was terrible in electronics, and I still am. Lucky, I did tear apart cars, so I didn't have as many problems. Now, to lower your assumed level of mechanical or electrical competency would be a very subtle way of allowing these girls to come into the system without being as insecure and without having to fight as many struggles. It is an easy way of helping freshmen of diverse backgrounds, regardless of their sex. The idea of having a professional woman or a number of professional women talk on their careers, but only to what their careers are and what their functions are, not the fact that they're female in these functions. I don't think it's necessary for me to say, "When I go on business trips, I have difficulty because men approach me." That's silly. But I would like to describe what I do, how Du Pont treats me as a person and as an engineer, and what I aspire to. And it's necessary to have women present their careers in order to establish them as models.

Bob Gardner: I'll respond to that too if I may. I talked about the fact that faculty should be made aware of, I didn't say the fact that females are different, but that there are attitudinal differences. For example, I think the data here clearly shows that females tend to need support; males don't show that need. One of the common things you see among engineering faculty is a challenge to a student. Negative feedback is the accepted route to performance. I would submit that faculty should be aware that with women, positive feedback may give better performance. You don't get better performance in all cases by putting somebody down to make them work harder; in some cases you might want to use the strategy of support and say, "You're doing very well." So I think the differences are very subtle. I don't think you'll find faculty altering their grading schemes for females or anything along those lines at all. But I think that the faculty has to be aware that the audience is no longer homogeneous. It's not simply a class of males.

Michael Fisher: What I wanted to say basically, since there are a number in the audience who are as distinguished as those on the panel, that those of us who have made the appropriate academy of science are usually not the ones to listen to when it's a question of discussing education. That is, those who would have made it into their particular profession by changing to another route or by struggling with the obstacles would usually succeed against the best efforts or worst efforts of any teachers. And the problem of an educational institution, which I take it was what Dr. Gardner was basically addressing, I think has hardly been addressed by any of the panel members; rather I think the discussion has been turned around. So what I really wanted to say, counting myself in the same age group as the older members of the panel, I think you are missing the point. You are taking the attitude that because I made it this way, that's the way it should be done. Now I think that is probably still true for those you want to make in your own image, who will come out at the top of the profession, but the point is an educational institution is talking about educating the B-stream, basically. Now it should, at the same time, make sure that it catches those at the very bottom by remedial programs and has the stimulation and advanced work so that it does the best possible for the good ones. The problem we're facing here is the problem of those in between. Those need helping, and those have to be adapted for the attitudes. One thing I would like to stress, it came through again, but as regard

to engineering, there's practically no image of engineering, even in high schools, for men or for women. The problem is then obviously worse for women because of the (lack of) role models. And I guess one of the things I would like to see in engineering, where the drop-out rates as far as I can see by any other areas are just phenomenal, is much more done by way of orientation for engineers and for that matter orientation for non-engineers about what engineering is. One talks about the freshman humanities course; there are efforts made every now and then to do relativity in the purer sciences for the freshmen. I haven't heard of things the other way around, that will sensitize the humanist to what engineering is about from professional engineers. So I think there's a lot of problem there. I myself would like to see discussed much more thoroughly the question (of the extent) to which you can do things differently or supplementarily for women. The problem has been faced at Cornell, at least for the so-called COSEP students, the underprivileged students, for whom there are remedial courses. These have been a source of friction between departments and so on, and it's easier to say they're underprivileged socially than to say they're underprivileged because of their sex or different attitudes. I think you would have to, as a practical matter, make courses open, but I don't see why you can't have a course whose frank appeal would be for the women engineering students, or at least I would like to hear this debated. So I guess the main thing I want to say is that those of you who have made it to the top of the profession, or even half way up now, must look at it from a different perspective, because the people we're talking about are, in some sense, the ordinary infantry soldiers, or at least the non-commissioned officers. I would urge you to address yourself more to the practicalities and pros and cons, looking back at your own experiences and those of others you have taught, of what can be done at the practical level.

Shirley Holmgreen: I'd like to address that. I think that addressing freshman engineers or sophomore engineers or anywhere at the university level, is the wrong place. It's not early enough. What Cornell University and every other university in this country needs to do is to develop some kind of program, in the engineering colleges in particular, to go to the high schools and junior high schools and tell them what engineering is about. Then you don't have the situation that Marilyn had that she made her decision in the last half of her senior year of high school and in the meantime had not gotten some of the things that she needed to get to prepare herself better for her college career. Now if this is the kind of thing that's happening, and I believe it is, our experience at least in Washington state is that the girls are making their decisions much later. You said this in some of your papers, and it's because nobody tells them when they're junior high school students that they can be engineers. And I don't just mean role models of other women engineers. The men engineers can go. We have a visitation program that the University of Washington sponsors. They send to high schools (and I think that's not low enough in grade) a team of three: a student engineer, a member of the faculty, and a member of industry. And this is a non-homgeneous team. You never know with whom you'll be going, whether it's going to be a civil engineer, a mechanical, an aeronautical, or what, you just go. Sometimes we bore the kids to death because they're required to go to these classes. Maybe it's a math class and the math teacher says this is a good thing to do, and half of the kids are asleep because the want to be theoretical physicists or some such

thing. Nevertheless, there are those in the classes who are being exposed to that sort of thing for the very first time, and whether they are men or women who are telling about it, at least they're hearing about it. And I think that waiting until they are freshmen in college is just baloney. Get to it earlier.

Dave Johnson: I want to respond a little to that. Shirley, I think what we've done here in our survey of our freshmen depicts just what you're talking about, that women are being acqainted with the opportunities in engineering earlier. I would submit that in subsequent years you're going to see women at least consider technical education at an earlier point in their high school careers. I think that message is being made, on a national level. What I get from the panel, though, is a healthy skepticism about any data that pertains to freshman engineers. I would submit that what we need to do is go beyond the freshman level and perhaps survey junior and senior women to see if in fact they are different. Perhaps we're in error to assume that the engineering profession is going to alter based on the students who are entering it, particularly when it deals with minority students such as women might be. I doubt very much if we'll ever reach a parity situation, where female enrollments will comprise half of the engineering students, and I doubt very much if the engineering profession is going to be terribly responsive to a minority group. The development of minority programs is really only about ten years old, and I doubt whether any one corporation or industry has had sufficient experience in bringing minority people, either blacks or women, into their ranks to see if the nature of the profession at their respective corporate levels has had to alter at all.

Shirley Holmgreen: I can only say that you're right about that. The forcing functions of the laws are not old enough yet for any good results to have come out. I think you will also find that corporations, as they differ in character, will each attack the problem differently. I suspect that women in the Cabot Corporation are very much more fortunate than in some of the others I could name.

Robert Charpie: I'm also the chairman of the Miter Corporation, which as you may know is one of the very large systems engineering corporations that works predominately for the federal government. We operate in two main areas. The larger one for which we're best known is the command control and communications area for the Air Force and the security agencies. But about half of the company is devoted to other governmental work of the systems engineering type. And we work for the civil agencies. This work has been building up, not surprisingly, very rapidly over the past decade, coincidental with the minority force efforts in this country. So we have the experience now of having built up a one thousand person technical organization mostly in the non-Air Force areas, ranging from the national intelligence agencies to the completely civilian agencies embracing HUD and DOT and mass transport. Now in this effort, about 30% of the professional staff is women, and it's the only experience I have where we've been at it long enough in a sufficiently dynamic organization not only to talk about the entrance jobs but to look at the early phases of what happens in the career development sense. Recognizing the particular effort that has been made in the last ten years and recognizing that Miter draws its revenue from the government and therefore has the civil rights agencies and equal opportunity agencies looking over its shoulder every moment of every day, it is

still true that within the group of people who came into the company at entry job levels and have now progressed through ten years, that the percentage of women at the advanced positions is about the same as it was in the entry job group. In other words, we have immediately below the Senior Vice-President who commands the whole Washington-based operation, seven divisions. Two of them have women division managers. We have five people with chief scientist titles who range across the operation divisions and have the intellectual responsibility for reconnaissance and quality control of the technical product. Two of these five are women. And we're maintaining between 25 and 35% of women in the new employment groups each year. These are not just engineering jobs. (We do) have science and mathematics and life sciences too, but the dominant theme is experienced engineers. We don't take too many fresh from college campuses. And so I take quite a lot of comfort in the quality of the experiment where you have the 20 to 40% of the representative levels occupied by women, recognizing the fact that although we started ten years ago, since we were working mostly with experienced women this meant that the large influx of women at the entry job level didn't take place until about five years ago.

Shirley Holmgreen: May I ask you whether the women who make up 30% of your professional staff are mostly engineers, are they computer scientists, or what?

Robert Charpie: The largest group probably are computer scientists, but if you take a look at Miter as a whole the largest group of all people in Miter are computer people. The men who have been in the company for twenty years will typically have started out as electrical engineers, gone through the electronics and radar bit, and wound up in computer systems. The women on the computer side were trained as computer systems engineers, and we didn't have those twenty years ago. So I don't know what kind of conclusions you draw from that. We've got sociologists, electrical engineers, mechanical designers. We do some very sophisticated crytopgraphic design, and the very best person in there is a woman who's the head of the design group and who's a mechanical engineer by training. You wouldn't expect to find a mechanical engineer at Miter in the first place, and you wouldn't expect to find a woman mechanical engineer, but she is a real whiz on the cryptic machines.

Shirley Holmgreen: The reason I asked that is that I think in most of the corporations that I know anything about, and certainly the one in which I work, it is typical that computer scientists are divided much more equally, men and women. I think roughly 30% of the computer scientists at Boeing are women. It is a new field, and one that has not been stereotyped with the laced boot-hard hat characteristics that so many of the other engineering fields, whether it's true or not, have, and consequently a lot of women have gone into it.

Sherry Koenig: I'd like to respond to Michael Fisher, because he brought up an issue that I think Bob was trying to get at, and that is what to do with the women who are undergraduate students now. (I'm concerned) not because of the data that Bob presented in his paper, but because of some experience I have in peer counselling with freshman and sophomore engineers. I think there is a real problem that needs

to be addressed now, and whether or not it is a fault of recruiting or changes in socialization or whatever, I think there is something that needs to be dealt with at the undergraduate level now. What alarms me is the talk of handling that problem with a COSEP type of program. My familiarity with the COSEP program, which is a minority support program here at Cornell, is that it does nothing but alienate the students who are involved in it and the students who are not involved in it. That is the last thing that I think should happen to women in engineering. I think that alienation could reverse all of the things you're trying to do in bringing women into the program.

Tucker McHugh: I think there's another reason for not having totally segregated programs for women. I work in Guidance and Testing here for students from across the university, and most of the engineers I see are leaving or thinking about leaving engineering. The vast majority of them are males. And I think that the kinds of programs and the kind of push you're talking about toward retaining women engineers is also going to retain male engineers, because certainly the ones I see fit those characteristics that you described for the freshmen women. These are a large segment of the men who have left engineering. So I think that's an even stronger reason for not segregating your programs. You're going to retain more men as well as more women.

Irene Peden: It's my belief, based on changes in the curriculum at the University of Washington over the last four years that there is a movement toward curricula that are not as heavily structured as undergraduate engineer curricula used to be. Students can now put together a traditional program leading to a B.S. in a particular major department the way they always could, if that's what they want to do. At the same time, if they want an interdisciplinary kind of programs that, let's say, might give them a basis for graduate work in some other field later on, they can put together what's called a Bachelor of Science in Engineering program. It's heavily engineering-oriented, and it might serve as a basis to do graduate work in nuclear engineering, which is a graduate department only at our school, or in bio-engineering, or some other very technical area. If they want to use it as a basis to get into law school or medical school, that can be done too, and often is. We have still another less professional curriculum that leads to a B.S., undesignated. We do not claim, nor do we ever allow the students who want to do that to believe, that they are prepared to practice the profession of engineering. It's more like a B.A. in the sense of simply giving you an education if that's what you want, and putting more science and engineering into the core of it than used to be the case. It still can be useful in terms of career objectives, if a student perhaps wants to take scientific and technical writing with it in the School of Communication and aim toward that kind of career. Combined with some business courses, I suppose it could lead to sales engineering and that kind of thing. But typically it's just a general Bachelors kind of curriculum. We are now seeing many more students transferring into the College of Engineering from Arts and Sciences, students of both sexes, than used to be the case. And it's my personal belief that we are accommodating a change in the norms of how young people are and what it is they want to know and what they want to contribute to society, and so forth. I believe that some of that is related to this effect in the curriculum and the other factors that have been mentioned.

I'd like to say something too about the concept of remedial programs. We've heard them suggested. We've heard them objected to, and I'd like to try a little sorting of that too. We had an excellecnt presentation by the Hall's concerning a credit course that was designed to teach those who needed the skills to use tools, and catch up a little bit with a deficient childhood, so to speak. (If you end up having been a child who played with dolls and then wants to take engineering, you've got a deficient childhood; that's all I mean by the word.) That's remedial. It's just a helping hand to bring you up to speed. It's a variable input system. Nobody says we're going to change the output standards. I'm sure almost all schools have, as we have, a situation in which you start getting engineering credit with calculus. The students come in who are not ready to start calculus because of not knowing in time that they should have taken a little more math in high school than they did. They can take freshman math courses that are pre-calculus, and they don't get engineering credit for them--they just take them if they want to be engineers. Then they're up to speed in math. Nobody penalizes them for it. Nobody says, "You needed extra help; therefore, you'll never be any good." Nothing is said or thought about it at all. And I don't see those situations as being different. Now at the other end of the spectrum, if we talk about supportive therapy for four years in order to keep a girl from freaking out and saying, "I can't handle it." just to keep her in school, I object, and I think everyone here objects, because we say, "That's not reality, and how is she going to hack it when she gets out of school?" The answer is she isn't; and I don't think I hear anyone saying that they think that ought to be done. What needs to be done, I think, perhaps is somewhere in between. It no doubt has something to so with retention of women engineering students, something positive that we would all be in favor of, and I wonder what you think is the level that should be reached there.

Carol Hall: In this course we taught, yes, we taught remedial skills. But I think that a component of this course that was at least equally as helpful as the remedial part of it was the spirit that developed among these girls out of the fact that somebody cared about them, somebody was willing to help them. There were two women out of five instructors, so there were role models for them to watch; admittedly we weren't as skilled as some of the men, but we were trying, and we did seem to have status in their eyes, so this made a big difference. I would also like to suggest that the Cornell experience and probably the undergraduate experience in many schools is not always a positive one for women. It's harder for women than it is for men. There are members of the faculty who are discouraging to women, and there is a feeling often that women aren't taken seiously. It's my opinion that because these things exist we have to support women in order to counteract all these bad things that are happening because of the male-dominated faculty and male-dominated society.

Robert Charpie: Having criticized many things Bob said, I'd like to offer two special pleas. As a businessman, I would like to see university faculty in the engineering schools, to the extent that the women entrants in the classes do have many of the characteristics that Bob finds in the Cornell women, be supportive for the articulation of many of those kinds of differences, rather than any attempt to mold or suppress them and force them into a real or misconceived notion of what an engineer is. Engineering as a profession and engineering as it is used

in the business world will prosper from the kind of breadth of cultural interest and breadth of interest in other people and from some of the other characteristics that Bob alluded to as being more visible in the women freshmen than in the typical experienced engineer or in the men freshmen engineers.

The second point I would make is that I think we should be very careful as we focus on the turnover problem, the loss of engineering students and particularly the loss of women engineering students as they go though the four years or immediately thereafter. We ought to be very careful in making up our minds what's good and what's bad. It's not necessarily so that the high loss rate is a bad thing, in my view. The criterion that I would like to see applied to judge the goodness or the badness of the loss is: "Are we producing enough engineers to meet the apparent needs of the society?" and "Is an increasing fraction of that number women?" Then if I could get a "yes" answer to both of those questions, then I would like to vote for getting busy and recruiting many more entrants, with the hope that they will diffuse out of engineering, having established themselves as being interested in technical material, and find other satisfactory professional endpoints. I do declare that this society needs more deep-seated understanding of technology and science in every aspect of this society. I am persuaded that it's a lot easier for people who think they want to be engineers and try it and then they discover they want to be something else to retain with them a keen understanding and appreciation of technology than it is to teach it to that other segment of the population who know they don't want to be engineers, who aren't interested, and who will put up every barrier to learning. We talk about not teaching "Bonehead English for Engineers," which I agree with, but let me tell you that that beats "Calculus for Poets."

Christine Smith: I'd like to make a couple of comments that I think are in that same vein. Concerning this discussion about whether or not women should be separated and how much remedial or laboratory or whatever skills should be taught, we're about at the overkill stage. For instance at Purdue we do have a one-hour, non-credit seminar. This is not a tremendous part of the one hundred thirty hours, four years experience that the students are going to have. We do call it a seminar, so it's not Women in Engineering 101. It's a seminar; it's a time to get together to discuss things and we're going to do some laboratory skills. Overwhelmingly, the students who have taken this course say that the number one benefit is the support--just to walk into a room where there are sixty other women. Next year, for instance, we'll have over two hundred women. We have fifty-seven places in the class. It's obviously optional. Not everyone takes it; not everyone will be able to take it, but at least it is there. I'm probably going to tell people who just want to come to go ahead and come, just so they can get that support.

I want to address something that Shirley said a long time ago, which is the importance of professional society meetings and influence. At Purdue we do have some grants to provide professional development travel money for students who are either undergraduates or graduates and who may request money from us to attend professional meetings. We just got this program going this spring, and we have seven students attending the SWE conference on this money. We have quite a bit of money left. I think

we'll have to educate the students that it is available and that they should try to get some professional contact, and I think that's a good way to do that. We're doing something. It hasn't been totally ignored.

Shirley Holmgreen: The only comment I would make there is that I would prefer that you spent that money sending them to the ASME convention, or the ASCE, or some of the others.

Christine Smith: We had no applications. We saved a lot of the money because we felt that somebody wasn't telling them that they might enjoy ASME or something like that. We will suggest that in the fall. I just think it's an educational thing. Once we get the word out, they'll do it.

Bob Gardner: I would like to make one comment. I won't say a single thing more. One of my motivations for writing my paper the way I wrote it was to try to forewarn people from industry that four years from now they may begin to see fundamentally different populations from what they're seeing now. I may be wrong, but in some sense I feel that it's better to be somewhat prepared and expecting it than to be taken completely by surprise. So I hope one thing that comes out of this is an active interchange between industry and educational institutions about what's going on, and so that we can work together in some sense in planning and discussion about what might take place. And I think that's happened here this morning. I'm very happy about it; I've enjoyed it a lot.

Athena Theodore: You might have to get up again. One of the ways that we perpetuate sexism is through the research we do and the conceptual frameworks and the methodologies that we use. The dichotomy of masculinity/femininity was something that was very much used in the social sciences up until about four or five years ago, and this is absolutely (out) for us because by doing this you put people in molds by saying that this is the "feminine perspective" and this is the "masculine perspective." We are saying that there is no such (thing), one or the other. So research studies are high risk in terms of publicizing these and letting others read them, if you use such conceptual frameworks as "feminine norms" or whatever.

There are also risks in asking students themselves what they think. They always tell you what they think you want to hear, and again, because women and men have been brought up within the whole sex-stereotyped framework, they will tell you what they think girls ought to say and perhaps what boys ought to say. So there is another danger in that. And I would suggest there that the patterns of behavior should be the places where you really ought to go and report the research. How many applied? How many were accepted? What were their competencies? What programs did they go into? These are facts which we can all live with, and probably will reveal the same kinds of attitudinal fixations that students themselves have. Freshman students are the last people I would ever ask anything. They just don't know where they are.

Bob Gardner: As a practitioner I have a certain orientation. I grant the research isn't perfect; it may be mislabeled. But on the other hand, I'm faced with decisions I have to [illegible] about students coming next year and what I want to do, and I don't [illegible] the luxury of establishing all that. I guess that's about all I [illegible]y. I wish I did have that

luxury, but I don't. The other thing I would like to say is that one of our freshman students in engineering, Nancy Reese, has been one of the conference coordinators, and so I'd like to hear her views of what I've had to say since she's one of the people I've been talking about.

Nancy Reese: I've been meaning to make a personal note concerning the need to reach students early with the message about engineering. I first was exposed to different aspects of engineering in my sophomore year of high school through the Engineering Explorer program. It's a Scouting Organization program which was sponsored by a local industry. And I'd suggest to any educational or industrial institutions that are concerned with reaching students early, women and men, that this is an excellent structure to work with. We went into various industrial atmospheres and worked with our sponsors who were practicing engineers.

Lane Mashaw: I can just add one little bit of input that is completely off the subject, except for one of the suggestions, and that is that we get to them younger. An experiment that we started last year that I think shows some promise is to work through the 4-H. We had 20,000 kids in an experiment last year, and we expect to have something in the neighborhood of 200,000 students getting curriculum in engineering starting at eight and nine years old. We have three sets of curricula so far, and we're working on more this summer. So we are trying to start with what for us is the big group, and that is the agricultural group, which is in every town and hamlet. And we think we will be hitting a very large sample very young for a long, extended period.

Irene Peden: I know that conferences are being held at universities all over the country. We have had one. We are having another. Our first one was flooded, over-subscribed. We couldn't believe it. I think if we had tried to put on a conference like that five years ago nobody would have come. I know that they are going on everywhere, and I know that there are summer institutes and there are various kinds of programs to inform high school women and teachers and counsellors, and junior high school women, and clearly others even younger about the opportunities and to get them thinking along those lines.

Dena Skalka: At Bell Laboratories, we not only go to high schools and junior high schools, but we take groups of students through our plant.

Marilyn Sessions: What I'd mention concerning the comment on the Explorer Scouts is that Du Pont Engineering Department has an Explorer Station specifically to educate some of the young high school students about engineering. And each of our divisions, design, construction, service, and research, put on various programs, and this year I will be involved in that. I don't know the make-up of these students yet, female or male. I imagine we'll have some girls, and I think this is a good way of making the contact early. If your particular industry has not been involved in this, perhaps those who are interested should write and find out how you can set up an Explorer Post so that this can expand and reach more people.

Irene Peden: Shirley mentioned the program that the University of Washington has. It is a team approach. There is always a member of the engineering faculty, who might be a woman or might not; there is always

an engineer from the professional working community, who might be a woman or might not; there is always an engineering student from the University of Washington, who might be a woman or might not. Sometimes there is also a community college contingent, depending upon what the high school wants. We can, upon request, put together an all woman team. We would not do that on our own initiative, but if a high school asks for it, and once in a while they do, then we can put together that kind of team. Some of the members of the team can be members of minority groups, and for the inner city schools we make a special effort there to see that they are. I know that these kinds of programs are being done quite widely.

I would like to ask another kind of question, based on Bob's paper, and to ask anyone in the audience who would like to do so to respond. The paper identifies some qualities associated with women engineering students; qualities like humanistic interests and expanded social awareness, orientation to human systems and human service delivery, etcetera, and suggests that these traits, although desirable, can be a liability to a woman in the engineering education system. It would seem to me that those are the very qualities that are being sought in potential engineering managers. I wonder if there is anything the universities could or ought to do to close that gap. We hear from our own advisory committee at the University of Washington that there are people in the industrial community, particularly management people, who feel very strongly that our students are just not able to cope with financial accountability on a job and with managerial kinds of skills. They see this as a great deficiency in our students and they tell us with vigor that we should be doing something about it. All of this in four years, which is difficult. We want them to be technically competent too, and we all understand that there is a problem there. But I'm wondering, should we be encouraging women engineering students to opt for some management training while they are in school? Would it have any effect on retention of women engineering students if we did?

Helen O'Bannon: At Carnegie-Mellon, the largest group of enrollees at the Masters level (in Business) are engineers. We also have an undergraduate program in administration and management science, which for administrative purposes does fall under the College of Engineering because it is highly quantitative and operations research-oriented. But I don't think you want to mix metaphors here. What we want in an educational sense, I think, are broadly, well-trained engineers, who then can move, as Dr. Charpie said, into any number of different career patterns or to advanced work at the graduate level. I also think the engineering curriculum at most places is not flexible enough, and do you then get a hybrid manager, or do you get a hybrid engineer at the undergraduate level? It seems to me you're going to get neither fish nor fowl by trying to train at the B.S. level an engineering manager, per se. Management skills come really after one has a good foundation, whether it be a liberal arts background or a technical background, and then pursues either on-the-job training or additional graduate work. I don't think there's that much advantage in trying to mix both these things at the undergraduate level. This is my own personal opinion.

Lilli Hornig: Although I'm fundamentally very much in favor of broadening the engineering curriculum, one of the dangers of building in essentially an interdisciplinary approach, whether it's with management,

with social concerns, is that there are very often no well established career ladders for people like that. This I think has been the death of many interdisciplinary programs in universities. I'm thinking specifically of programs in things like urban affairs, social planning types of things where people graduate with a very broad background and not enough specific skills to get started, and there is in fact no well-defined career ahead of them. I think that's something we need to be very conscious of. It's particularly applicable to women, I think simply because, as we've found at Brown and I know other places have had similar experiences, women tend heavily to go into these interdisciplinary things because they include all these areas of societal interest that these women have. Then they find when they get out that they are really just unemployable in what they consider to be their own fields. I think this explains something that was mentioned yesterday or the day before. There's a high correlation between women graduating and not continuing to work in what was their undergraduate major or even thier graduate major. I would add that caution.

Barbara Wilson: I'd like to ask a question concerning the recommendation that women take management courses. Management varies a lot from school to school and even within the school as to what different aspects are stressed. What kind of management did you mean? In my engineering department and in many at MIT management courses aren't required, but they do highly recommend an economics course, basic introductory micro-economics for business situations. I don't know if that's what you meant by management, or something in terms of organizational theory, or what. I was curious.

Irene Peden: I didn't really have any specific course in mind at all. I'm telling you what is said to the college administration by the visiting committee.

Tucker McHugh: I think there is a specific answer to that, at least for women. It means accounting, not economics.

Judith Carberry: I just wanted to make a comment about one thing that had been said earlier that doesn't relate to the previous question. At Delaware, we seem to have a group of girls who are really with it. They know why they're in engineering. As the university tries to maintain quite an active and high profile in the area, we seem to get women who know what engineering is all about, who know why they want to be engineers, and who darn well want to succeed in it. And we advise them, as well as most of our students, not to be lifeguards in the summer nor go out and do surveying, as engineering students are wont to do because they seem to make a lot of money that way. We advise them to get jobs which give them profitable experience during their summer months. Our women students recently have seemed to get the better jobs, and these girls therefore acquire a great deal of experience which puts them way ahead when they graduate, and already catapults them into a position where they know whether they want to be in research, management, sales, or another aspect of engineering. We think that this is quite profitable. It's better than having them take some kind of an industrial management course, something which tells them what to do instead of putting them in a position where they can actually do it.

Melissa Brown: I want to pick up some earlier comments, changing the subject a little bit. I have participated in probably a dozen of the

university-sponsored programs for junior and senior high school students across the nation in the last two or three years, and I believe very strongly in them. I've seen some very strong results from them, and a significant vote of confidence from the girls who do attend these. But there are inherent limitations in those programs. I would encourage those of you at the universities to do these if you can, but recognize that you're asking the people to come to you, so there's already a pre-selection process. There are many counsellors who do not encourage girls to attend those; there are many parents who do not encourage girls to attend those. So do them, but recognize the limitations. And I would suspect that many of the industry programs that have the students come to the industry have those same limitations. I would therefore encourage you very strongly to look at the kinds of programs which the University of Washington has in which you send teams out to the schools, and the students are there, they're a captive audience, they have to listen. And, granted, some of them may be bored, but you're going to get the message across to a lot more people. It is critical to get the message across at least at the junior high school level, not just so they can decide that engineering may be the career that they want, but so that they realize that technical subjects are essential for a significant number of career choices. If they don't take math and science in high school they have automatically precluded perhaps 40% to 50% of their career choices without ever knowing that they've done that. Now that's not just girls who do that. I've known men who have had to drop out of engineering for the very same reason; some highly competent men, but they simply did not have the tools and skills that they needed. So I'd encourage you to go out from the schools, I'd encourage you to organize those programs from the universities and industries if you can. The last comment that I would make is that it seems to me that a lot of what we're talking about is humanizing the education process, and I don't think we need to categorize it into male and female students. Those who need it will respond. And what we're trying to do is humanize it for everyone who is in the system.

Judith Carberry: I just want to ask Melissa one question about her comment. We run these programs, recruiting programs if you want to call them that, and just about the only time that we really have a full force of people going out from the university is when we go to the technical schools such as Brooklyn or Baltimore Polytechnic, because we feel that we get a substantial return on our investment of time, money, and energy at these particular schools. But we simply can't get faculty or representatives from the university to go out to all the junior highs or the local senior highs because this takes time away from work, primarily research and publishing which one must do in order to get promoted. And so we have a very low response from faculty to do this at various local schools from which we wouldn't get a very high return of students.

Melissa Brown: I think probably Irene can address that better than I can. My only comment would be that it's a matter of a sales job on your part, of your raising the consciousness, if one uses that term, of the people who would be participating, that this is in fact a social obligation that we have to people and we don't measure the returns in the direct number of people who sign up in our courses in the university.

Judith Carberry: But these are the things that count to the university.

Melissa Brown: Well, maybe you need to reassess what counts to the university... I mean you with your professors need to reassess what counts to the universities, and I think Irene could probably address how they've handled that at Seattle.

Irene Peden: I have the same goals and I think that we would like to be able to convince all of the faculty that it's in everybody's best interest if they would give a good deal of their attention to what we call service. However, there are teaching, research, and service within the university framework, and service does not come first. If you're within academia you know that; if you're without academia, you might as well know it. I guess a reason that we have been so successful with our program is that we're pretty good sized, and we have a fair number of people on the faculty who are in a position to do that kind of thing. We have to leave it up to them to decide how much time they can give to it. We have enough people to put into the team situation that no individual faculty person necessarily goes more than once in an academic year. It's pretty well concentrated within a certain number of months and not strung out over the whole academic year either, and I think that's a factor. We certainly do have some young faculty who are very active in their research and in carrying on all the things that young faculty need to do in order to be promoted, who also have strong service records. And they will be successful as junior faculty becoming senior faculty to the degree that their heavy service records are simply an appendage to very strong records in teaching and research. And some of them are so good and have so much energy, and I think the energy level has a lot to do with it, that they can do all that, and they do. We have some other junior faculty who feel so committed to this kind of thing that they will do it anyway. And that's a calculated risk for them, and we can only assume that they know what the risk is and that they decided to take it. We also have, within our college, one rather small department, a very vigorous and active department but a very small number of faculty and a very small number of students, and they are so active in the high school visitation program that you would think they had a cast of thousands. But one of their motivations is that they need more students and they are all uniformly committed to trying to motivate more students to go into their field. I just think our size is a factor in our ability to keep this kind of thing going.

Shirley Holmgreen: I would like to add to that. Going back to what I said earlier, the way that I got involved in that program was through my technical society. The University of Washington sent out letters to all of the technical societies in the Puget Sound Engineering Council inviting us to send in our names if we were interested in the program, and that's the way I would say fifteen or twenty people in the AIAA got involved and have stayed with it. I guess I've never gone more than twice a year, and the most time I've ever spent on it was about four hours for one day. So that's at the most one working day out of your life.

Lane Mashaw: One of the things that I think industry needs to recognize is that industry is out there where the students are. If we just tried to stay in our own state, to go to the corners would take me two hundred miles each way. So it's a two-day trip when I go to the corners. But for the people from industry, we'll meet them there and they'll spend their two or three hours. So I think that if we're going to get such programs going, the profession is going to have to do it, and the uni-

versity is going to have to assist, but I don't believe that it is really reasonable to think that the university (can carry it). think we have another problem, and that is credibility. When the industries are out there, the profession is trying to attract bright, young people. I think the faculty and students are suspicious when we are out trying to maintain our little empires as university representatives.

Melissa Brown: I would agree very strongly with that. I think wherever possible, if you can have joint teams of university people and industry people that's a very good combination. As far as being remote from a lot of areas of the state, that's valid. I would suspect that some leadership, some direction, some orchestration, might come from the universities out to industry. I would agree that it's industry's responsibility to follow through, but I think you'll probably have to offer a lot of them the stimulation, and sort of the outline of a program of the kinds of things you would like to see them doing within your state. Then many industries, I'm sure, would follow through, but if you leave it to each of them individually to do on their own, possibly a lot is not going to happen.

David Johnson: I think there's one other source that really hasn't been approached at all, and that's the guidance committee of the ECPD and the EGAC, which for years has been trying to get organized to recruit engineering students on a national basis. I guess I'm a little leary of university-based efforts; I think they're good, when the time is right. When the times turn sour, quite frankly, they're probably vulnerable. I think we have to recognize that fact. Right now is a very opportune time for students to enter engineering. But engineering employment is a cyclical one; it has historically been so, and when things have a downturn I'm fearful that our message may not be too well received by prospective students. So I'd much prefer to see some kind of a national effort. I'd much prefer to see ASEE and SWE implore the guidance committee of the ECPD and the Engineers Joint Council, to go to Dave Riescera and say: How can women have a more active role? How can SWE and how can ASEE assure greater impact on high school women in conveying the opportunities that exist in engineering today? I don't think that's really been addressed.

Irene Peden: I'd like to say something about that in my role as Vice-Chairman of the IEEE's Educational Activities Board, and as Chairperson of the minority committee of that board, which includes women because they're a minority in electrical engineering. We have done some things toward that end. There is in existence now an issue of the IEEE Transactions on Education, February 1975, which is completely devoted to women in engineering. It was edited by Martha Sloan. It was a work of the EAB minority committee to get that launched. The University of Washington had a very successful conference on women in engineering last fall. IEEE, together with IBM, helped us to publish the proceedings of that conference. It's not just the talks and summaries of the discussion sessions but also contains a professional evaluation section which was done by the University of Washington's Educational Research Institute. It also contains a summary of the procedures and the time-track and tells how to put on a conference like that. At IEEE's request, we delivered two hundred copies to the Society of Women Engineering to be distributed. Half of those will go to their student sections, so every student section will have one. IEEE got four hundred of them. They will give a

copy to each of the sections of the IEEE with a request that they think about working with their local educational institutions to put on such a conference. IEEE will in turn deliver several hundred copies to Dave Riescera, and to EJC with a request that they give it visibility. The publication is focused on women engineers per se. Certainly IEEE is not the only engineering society doing those kinds of things. ASEE has an Affirmative Action Committee and the women's aspect of that is headed by Professor Helen Plants of West Virginia. They organized some sessions for the recent annual meeting of the ASEE, and those are often attended by engineering educators and sometimes by their administrators, so somehow the word gets spread on that.

There are some movies on Women in Engineering in existence. MIT has a new one. There are others. There are brochures being sent out from all kinds of institutions on women in engineering. Many communities' high schools have access to those. It's my personal belief that where we are now on the recruitment of women in engineering is that we have done a pretty good job. I believe that we are still at a place with ethnic minority recruitment where we need to focus on special programs, special brochures, related to the recruitment of minority people for the engineering field. (Personally), I believe that where we are with women is that it's time we said, "O.K. We've started something and it has momentum and it's going." And what we need now, in my opinion, is literature, movies, various kinds of things which simply display what the engineering profession is like, and show pictures of women engineers and students in a simple, natural way and say, "Here they are. They're doing it." I think it would have a higher impact now. I have suggested to IEEE, and we have had some contact I believe with ECPD and EJC about this, that perhaps it is time that a mew movie were done to replace one that was done in about 1966. It was done then by Eta Kappa Nu and EJC and I forget who else. I was about engineering as a field, and it was an excellent movie in its own time. It touted engineering as being very science-oriented. It was very big on the space program which was very big at that time. The students shown had crewcuts and the clothing that was appropriate to 1966. In other respects it was an extremely good movie, and it showed a number of universities and students in a number of different kinds of engineering fields. It was an interdisciplinary effort. We looked at it at the university last year just to see if we wanted to use it in our program and the students who were with us to watch it said "It's wrong for the times and it will turn people off." We believe it's time that a movie like that were redone to fit the mid-1970's. Instead of emphasizing the space program and science aspects of engineering so much, it's time to talk about environmental things and how engineers contribute to (the solving of) societal problems and how engineers contribute to bio-engineering, plus all the things that engineers have done and are still doing related to energy and the space program. The original movie I believe showed one woman engineering student. And unfortunately it showed her as a person who had started in nuclear engineering and then had gone into technical writing, and I found that to be unfortunate. And to whatever degree I have any involvement with a future movie that might replace that one, I would hope that we could show technical writing and technical editing as a viable career option for engineering majors, but perhaps not have the woman be the one who goes by that route. I would hope that we'd have more women shown in a natural kind of way. I think that's where we are. It would be an extremely expensive movie to produce. It would take a joint effort.

Dena Skalka: AT&T is in the process of making a movie about women in engineering, and they are using a good number of women engineers in Bell Labs.

Irene Peden: Good. I hope that will be generally available. Maybe it will do the job I'm talking about. I think that (something) like the Piece of the Action film is still needed for blacks. I think that's where we are there, but with women I think we're a little bit farther down the track.

Lilli Hornig: This request needs to be made for my own benefit in my capacity as Chair of the National Research Council Committee on the Education and Employment of Women in Science and Engineering. I would plead with anyone here who has materials, conference reports, and so on concerning the kinds of things you've been mentioning, Irene, to send them to me, either at the National Research Council, care of Dr. William Kelly, or at Brown University, Providence, Rhode Island, 02912. We are very much in need of input from the engineering side. The committee, as it was constituted by the National Academy of Sciences, leans heavily toward academic science. We've tried to broaden out a little bit. We have one woman engineer from industry, but I think we need all the input we can get. I'd like to state, just in a general way, that this conference has been tremendously helpful to the work of that committee, which is just really getting underway now, and I'm very grateful to all of those who organized it and all of those who've contributed.

Irene Peden: Well by a funny coincidence we started out with a conference that says its about "Women in Engineering--Beyond Recruitment", and what did we end up with? We ended up with recruitment. I don't know how I feel about ending the final session on that note, but I think I will acknowledge the length of this session, which has been very long, and I think you've been just marvelous to sit there for two hours and forty minutes. I think the panel was marvelous, and I would like to thank each and every one of them for their very unique contributions, and to reinforce my thanks to Bob Gardner and to Mary Ott and the people here at Cornell for all the work behind the scenes and on the scenes that went into this very fine conference on women in engineering beyond recruitment.

*****

Conference Participants

Aghavni A. Bedrossian	Ph.D. candidate in Chemical Engineering Butler Hall, Columbia University New York, New York 10027
J. Melissa Brown	White House Fellow Office of the Under Secretary of State for Economic Affairs Washington, D.C. 20016
Lynne H. Brown	Counsellor and Administrator Math/Sciences Building Purdue University West Lafayette, Indiana 47907
Esther Lee Burks	Assistant to the Dean and Ph.D. candidate in Industrial and Systems Engineering Office of the Dean of Engineering Georgia Institute of Technology Atlanta, Georgia 30332
Malcolm S. Burton	Associate Dean, College of Engineering 170 Olin Hall Cornell University Ithaca, New York 14853
Judith B. Carberry	Assistant Professor Department of Civil Engineering University of Delaware Newark, Delaware 19711
Herbert J. Carlin	Director, School of Electrical Engineering 226 Phillips Hall, Cornell University Ithaca, New York 14853
Robert A. Charpie	President, Cabot Corporation 125 High Street Boston, Massachusetts 02110
David Christison	Manager, Planning and Technology Mobil Oil Corporation 150 E. 42nd Street New York, New York 10017
C. W. Clump	Associate Dean College of Engineering and Physical Sciences Lehigh University Bethlehem, Pennsylvania 18015
Sandra O. Davis	Assistant Professor Student Counseling Bureau Institute of Technology University of Minnesota Minneapolis, Minnesota 55455

Anne I. DeVore	Counselor College of Engineering and Applied Sciences University of Colorado ADI-1, Boulder, Colorado 80302
Mildred S. Dresselhaus	Professor of Electrical Engineering Massachusetts Institute of Technology Cambridge, Massachusetts 02139
Jennie T. Farley	Director, Women's Studies Program 431 White Hall, Cornell University Ithaca, New York 14853
June Fessenden-Raden	Associate Director of Academic Affairs Biological Sciences Division 118 Stimson Hall, Cornell University Ithaca, New York 14853
Elizabeth Fifer	Assistant Professor, English 536 Maginnes Hall, Lehigh University Bethlehem, Pennsylvania 18015
Michael E. Fisher	Chairman, Department of Chemistry 124 Baker Lab, Cornell University Ithaca, New York 14853
Sharon Friedman	Assistant Professor, Journalism C07 U.C., Lehigh University Bethlehem, Pennsylvania 18015
Ronald B. Furry	Professor, Agricultural Engineering 220 Riley-Robb Hall, Cornell University Ithaca, New York 14853
Robert E. Gardner	Director, Advising and Counseling College of Engineering 170 Olin Hall, Cornell University Ithaca, New York 14853
Jayne Gasienica	Assistant Director of Admissions New Jersey Institute of Technology 323 High Street Newark, New Jersey 07103
Paddy W. Gough	Assistant to the Dean College of Engineering Georgia Institute of Technology Atlanta, Georgia 30319
Carol K. Hall	Postdoctoral Research Associate Department of Chemistry 204 Baker Lab, Cornell University Ithaca, New York 14853

Thomas M. Hall	Postdoctoral Research Associate Department of Materials Science and Engineering 129 Bard Hall, Cornell University Ithaca, New York 14853
Paul L. Hartman	Professor and Associate Director Applied and Engineering Physics 510 Clark Hall, Cornell University Ithaca, New York 14853
F. W. Holm	Associate Professor Department of Mechanical Engineering Texas A&M University College Station, Texas 77843
Shirley A. Holmgreen	Senior Group Engineer 737 Aerodynamics Staff The Boeing Company Renton, Washington
Engin I. Holmstrom	Policy Associate American Council on Education One DuPont Circle, N.W. Washington, D.C. 20036
Lynne Holt	Assistant Professor Department of Civil Engineering Engineering Quadrangle Princeton University Princeton, New Jersey 08540
Lilli S. Hornig	Executive Director Higher Education Resource Service Brown University Providence, Rhode Island 02912
Yueh-ying Hu	Associate Professor Electrical & Computer Engineering Syracuse University Syracuse, New York
David C. Johnson	Director of Engineering Admissions 223 Carpenter Hall, Cornell University Ithaca, New York 14853
Layton E. King, Jr.	Manager, Career Development Mobil Oil Corporation 150 E. 42nd Street New York, New York 10017
Sherry Koenig	Ph.D. candidate, Industrial Engineering and Operations Research Upson Hall, Cornell University Ithaca, New York 14853

Martha S. Kopp	Student, Civil Engineering University of South Florida Tampa, Florida 33620
Howard C. Kramer	Associate Dean of Students for Counseling 103 Barnes Hall, Cornell University Ithaca, New York 14853
Carolyn H. Krulee	Counseling Coordinator The Technological Institute Northwestern University Evanston, Illinois 60201
Gilbert K. Krulee	Professor, Industrial Engineering The Technological Institute Northwestern University Evanston, Illinois 60201
Mary J. Kummer	Assistant Professor, Engineering Graphics Pennsylvania State University State College, Pennsylvania 16801
Margaret E. Law	Senior Research Associate and Lecturer Lyman Lab of Physics Harvard University Cambridge, Massachusetts 02138
Lora Liss	Affirmative Action Officer Alumni Memorial Building Lehigh University Bethlehem, Pennsylvania 18015
Elisabeth R. Lyman	Research Assistant Professor 256 Engineering Research Lab University of Illinois Urbana, Illinois 61801
Harit Majmudar	Professor and Head Department of Electrical Engineering Worcester Polytechnic Institute Worcester, Massachusetts 01609
Xanthippi Markenscoff	Assistant Professor Engineering Science and Mechanics Virginia Polytechnic Institute and State University Blacksburg, Virginia 24061
Lane H. Mashaw	Professor 112 Marston Hall, Iowa State University Ames, Iowa 50010
Jane Tucker McHugh	Counselor, Guidance and Testing 203 Barnes Hall, Cornell University Ithaca, New York 14853

Edward T. Misianzek	Associate Dean of Engineering Clarkson College of Technology Potsdam, New York 13676
Kathryn M. Moore	Assistant Professor, Education 215 Stone Hall, Cornell University Ithaca, New York 14853
David Morris	Assistant Dean School of Engineering and Applied Science Thorton Hall, University of Virginia Charlottesville, Virginia 22901
Joseph R. Nedrow	General Motors Corporation Detroit, Michigan
Helen B. O'Bannon	Associate Dean, College of Engineering 110 Scaife Hall Carnegie-Mellon University Pittsburgh, Pennsylvania 15213
Laura K. Olson	Assistant Professor, Government Maginnes Hall, Lehigh University Bethlehem, Pennsylvania 18015
Peggy A. Ota	Assistant Professor Department of Electrical Engineering Lehigh University Bethlehem, Pennsylvania 18015
Mary Diederich Ott	Research Associate College of Engineering 170 Olin Hall, Cornell University Ithaca, New York 14853
John B. Parrish	Professor of Economics Commerce West, Box 69 University of Illinois Urbana, Illinois 61801
Irene C. Peden	Associate Dean of Engineering 367 Loew Hall FH-10 University of Washington Seattle, Washington 98195
Christine Roysdon	Librarian Lehigh University Bethlehem, Pennsylvania 18015
Frances M. Richardson	Research Associate Professor Engineering Research Services Division North Carolina State University Raleigh, North Carolina 27607

Byron W. Saunders	Dean of the Faculty Director, Industrial Engineering and Operations Research 321 Upson Hall, Cornell University Ithaca, New York 14853
Marilyn L. Sessions	Metallurgist Engineering Technology Lab, Bldg. 304 E.I. Du Pont de Nemours and Company Wilmington, Delaware 19898
Dennis Shay	Assistant Professor, Physics 440 W. Brooks, Room 131 University of Oklahoma Norman, Oklahoma 73069
Christine A. Shoemaker	Assistant Professor, Environmental Engineering 403 Hollister Hall, Cornell University Ithaca, New York 14853
Susan E. Siedenburg	Salaried Recruiting Corning Glass Works Corning, New York 14830
Dena Skalka	University Relations Bell Laboratories 600 Mountain Avenue Room 3D326 Murray Hill, New Jersey 07971
Martha Sloan	Assistant Professor Department of Electrical Engineering Michigan Technological University Houghton, Michigan 49931
C. Norbert Smalling	Associate Dean of Students Clarkson College Potsdam, New York 13676
Christine D. Smith	Department of Freshman Engineering Purdue University West Lafayette, Indiana 47907
Ann C. Stenbeck	Director, Office for Women West Engineering Building University of Michigan Ann Arbor, Michigan 48104
Paula Stone	Ph.D. candidate, Civil Engineering Massachusetts Institute of Technology Cambridge, Massachusetts 02139
Athena Theodore	Professor of Sociology Simmons College Boston, Massachusetts

Edward J. Trethaway	Associate Director Development Office 437 Day Hall, Cornell University Ithaca, New York 14853
Jane L. Warner	Chevrolet Engineering Center General Motors Corporation Detroit, Michigan
Sheila Widnall	Director, Office of University Research Department of Transportation 400 7th Street, S.W. Washington, D.C. 20590
Barbara Ann Wilson	Student Massachusetts Institute of Technology 320 Memorial Drive Cambridge, Massachusetts 02139
Jacques L. Zakin	Professor Department of Chemical Engineering University of Missouri-Rolla Rolla, Missouri 65401
John A. Zohlnan, Jr.	Technical Personnel Manager Scott Paper Company Scott Plaza 3 Philadelphia, Pennsylvania 19113